UNIVERSITY OF CAIFORNIA

Santa Barbara

Implementation of Common Core State Standards & the Standards of Mathematical Practices

How Can Professional Development Support this Process?

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy
in Education

by

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March 2016

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December 2015

ACKNOWLEDGEMENTS

I want to express my gratitude and many thanks to my committee for their support and encouragement: Dr. Mary Brenner, my committee chair, Dr. Danielle Harlow, and Dr. Tine Sloan. I offer my sincere appreciation for the learning opportunities provided by my committee and I'm very appreciative of Dr. Brenner's patience and guidance.

My completion of this project could not have been accomplished without my experiences and association with Dr. Sloan and the Teacher Education Program at UCSB. The dedicated educators in this department continued to support and challenge my learning throughout this process. I will forever be blessed by this experience.

Finally, to my loving and caring family, Bill, Mark, Amanda and Ryan: my deepest gratitude. Your continually encouragement was much appreciated through this long process. Much love to all of you!

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ABSTRACT

Implementation of Common Core State Standards & the Standards of Mathematical Practices

How Can Professional Development Support this Process?

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Vanessa L. Walker

There is a need for effective professional development to build the skills needed to teach the Common Core State Math Standards (CCSMS) and the Standards of Mathematical Practices (SMP). The purpose of this study was to explore teachers' perspective of the SMP, the implementation process teachers were using for these practices, how they were transforming their teaching practices to match these new requirements and the role professional development (PD) played in this process. Qualitative data was gathered through teacher interviews. Analysis of the collected data uncovered common themes, including positive implementation perspectives and implementation expectations, challenges and concerns. Participants had strong positive feelings regarding the changes the CCSMS and SMP brought to education. They were excited because, even in the early stages of using some of the SMP, they saw positive results with students' mathematical thinking. Teachers also expressed concern with their lack of experience and knowledge of these standards, and the challenges some students were having with these new standards. When it came to PD, participants indicated a need for diverse opportunities to expand their skills regarding using the CCSMS and the SMP in their teaching. These participants felt that PD needed to address their needs based on their level of knowledge and skills.

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CHAPTER 1---INTRODUCTION

Background:

The Common Core standards have been publicized as rigorous learning standards that require students to have a deeper understanding of concepts and adequately prepare students for college. The Common Core State Standards (CCSS) initiative provides a single set of educational standards in English language arts and mathematics for kindergarten through 12th grade. The CCSS were developed by the National Governors Association (NGA) and the Council of Chief State School Officers (CCSSO) and were endorsed by the American Federation of Teachers (AFT). Forty-six states along with the District of Columbia have adopted the CCSS. The standards are consistent across states and are aligned to the expectations of young adults entering college and/or careers. The CCSS require a move from a fact-based instructional and assessment style toward teaching that cultivates problem solving, critical thinking and requires students to cognitively evaluate their thinking. These standards prepare students academically to compete with students across the United States and abroad.

Results from the *Trends in International Mathematics and Science Study* (TIMSS, 2011) indicated that fourth-grade and eighth-grade students in Asian countries outperform their American counterparts in a variety of mathematical concepts. In order to improve mathematic achievement in the United States, research studies suggested that the mathematics curriculum become more focused and coherent (California Department of Education, 2012). The Common Core Standards were created to address the stagnant academic progress of students in the United States. These standards provide consistent

learning goals that prepare students for careers and college expectations. Although there are fewer CCSSM than past national or state standards, a deep learning of concepts is emphasized within these standards. An added component to the math content standards, called the Standards of Mathematical Practices (SMP), defines how students should learn mathematics. These practices add an extremely challenging aspect to the CCSSM; they characterize what students are able to do when they learn mathematics with conceptual understanding. These practices demand teachers to transform their teaching practices and approaches when teaching mathematics. The Standards of Mathematical Practices are:

> (1) Make sense of problems and persevere in solving them.
>
> (2) Reason abstractly and quantitatively.
>
> (3) Construct viable arguments and critique the reasoning of others.
>
> (4) Model with mathematics.
>
> (5) Use appropriate tools strategically.
>
> (6) Attend to precision (communication with others using clear definitions in discussion and in their own reasoning).
>
> (7) Look for and make use of structure.
>
> (8) Look for and express regularity in repeated reasoning (California Department of Education, 2012, p. 6 & 7).

The Standards for Mathematical Practice offer an opportunity for students to engage in mathematics. For teachers, the importance lies in making a connection between the content of mathematics and the practices (or process) of mathematics. According to Russell (2012), the Standards for Mathematical Practices focus on the meaning of mathematics and they must receive the same attention as any other standards with planning and instruction devoted to them. Since the goal of these mathematical practices is to build mathematically proficient

students, it is important for teachers to have a true understanding of what these practices look like in the classroom and how they can support their students in achieving these practices.

For school districts in California, the 2013 school year was considered a transitional year for the implementation of the Common Core Standards; this means that districts had the option of considering the implementation needs of these new standards. Because Common Core Math Standards and the Standards for Mathematical Practices would require a major shift in teaching practices for their teachers, the school district focused on in this study decided to use the transitional year to provide their teachers with professional development which focused on the Common Core Math Standards and the Standards for Mathematical Practices in order to support them for full implementation of the standards in the 2014 school year. This decision provided an opportunity to collect data on teachers' perception of this process, changes in their teaching practices and what future support they may need in their classroom or through professional development. The district will use these findings to support teachers during the full implementation school year. These series of professional development created by the district also provided an opportunity to see how 'real world' districts are handling PD that is provided within the time and funding constraints of typical school districts.

This study gathered data from teachers who participated in four professional development (PD) session over a period of eight months in the 2013-2014 school year. This PD was provided by the school district where they teach. The PD sessions varied in length from two to five hours. The focus of these PD sessions explored teaching practices that support the Standards of Mathematical Practices.

Statement of the Problem

The Common Core State Math Standards and the Standards of Mathematical Practices represent an unprecedented and consolidated effort to provide U.S. children with a high quality, focused mathematical education. This process depends on K–12 schools, state education departments, and higher education institutions to make a commitment in supporting a change in the current P-20 educational system. Higher education plays an important role in building a relationship with the K-12 schools and state education departments by committing research that supports the success of the Common Core State Standards.

Currently, research does not consider teachers' perspective of the Common Core Standards of Mathematical Practices, the implementation process teachers are using for these practices or how teachers are transforming their teaching practices to match these new requirements. There is a need for effective professional development to build the skills needed to teach these new set of standards. While researchers have focused their attention on creating quality professional development, there has been little research on how school districts can implement professional development within their time and financial constraints. There is also limited research into the role PD is playing or can play in supporting teachers through the implementation process of the Common Core Standards of Mathematical Practices.

Acquiring new teaching practices, supporting teachers in the implementation of these teaching practices, and how these practices effect student achievement is a huge undertaking for any educational system. Higher education, state education departments and school

districts need to consider a process that will allow teachers to express their needs in order to be successful in creating professional development that provides students with quality teachers. Future research can support the success of these standards by identifying effective teaching practices, the implementation process, and teachers' professional development needs.

Purpose of the Study

In order for professional development (PD) to be meaningful for teachers, it must focus on information that is relevant to the teacher and useable in the classroom. Often the PD offered by universities, school districts or administrators focus on what they believe teachers need, rather than asking teachers what they need. Using two recommendations from NCTM (*Connecting Research & Practice at NCTM,* 2007*)* the intent of this study is to (1) investigate an urgent problem of practice, how to implement the Common Core SMP, and (2) connect this research to useful ways in which all interested parties may use it to create professional development, which supports teachers with this implementation process. This study will provide data regarding the implementation strategies and challenges teachers are facing as they transform their teacher practices to support the Common Core Standards of Mathematical Practices.

The data collection was conducted through an interview process. This allowed insight into teachers' views of their preparation of the SMP through PD and what teachers were doing during the implementation process of these mathematical practices. The data will convey teachers' perceptions on how PD has supported them as they are applying new teaching practices, and what future support they need. The collection of this information

occurred after teachers participated in a series of professional development opportunities provided by the school district in which they work. These findings will provide a research-based analysis that states, universities and districts may use when planning future professional development to address teachers' needs on implementation of the SMP. As school districts have limited allotted time and funds for implementing professional development for teachers, they must make informed decisions about the types of PD opportunities to offer, for how long, and for which staff. This study may help design effective professional development; determine support teachers need in the classroom after attending professional development; and in planning subsequent professional development. It can also provide foundational information for future researchers by identifying effective teaching practices, the implementation process, and teachers' professional development needs. These are important topics as researchers consider how to support districts and state education departments in the successful implementation of the Common Core Standards and the Standards of Mathematical Practices.

Research Questions

The following research questions will be addressed in this study:

1. What are teachers' perspectives of the Common Core Standards of Mathematical Practices?
2. What happens when teachers start to implement the Common Core Standards of Mathematical Practices?
3. How has professional development supported teachers through this process?

Significance of the Study

In order for teachers to benefit from PD it is essential that they feel the PD focuses on meeting immediate needs. This study may inform Universities, County Offices of Education (COE), districts and schools, of the benefits of collecting data on teachers' needs before creating and providing PD programs. For universities, by conducting interviews, researchers can find the most urgent needs of the teachers and provide PD that addresses proven practices in useful and usable ways to meet these needs. This process may help provide a missing link between research and classroom practices. For educational leaders at the county and district level, collecting data from teachers may provide valuable information regarding how limited time and funds are best spent to support teachers.

CHAPTER 2---REVIEW OF LITERATURE

Effective professional development is often seen as vital to school success and teacher satisfaction. In relationship to the implementation of the common core standards it is essential to determine what teaching practices support the SMP, why these teaching practices are important, what these teaching practices look like in the classroom, and how PD can support teachers in the implementation of new practices.

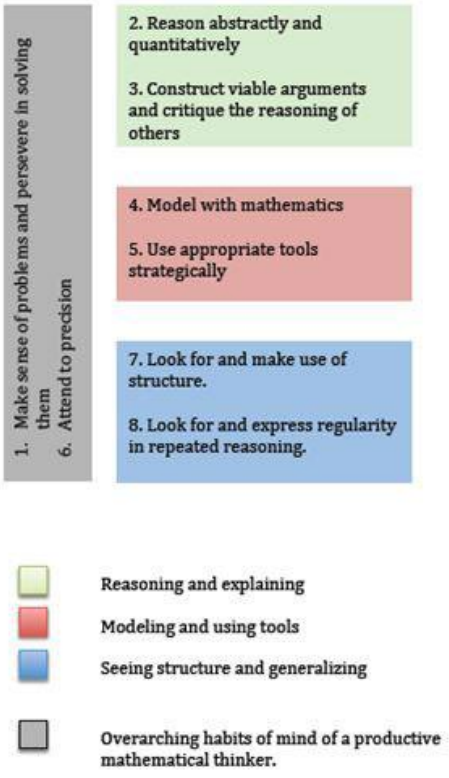
The review of the literature for this study is presented in four sections. The first section examines the Standards of Mathematical Practices. It includes a brief history of the creation of the SMP practices as well as a discussion of the shifts in teaching practices needed to implement the SMP. The second section examines why these teaching practices are important and what they look like in the classroom. The third section examines how PD can support teachers in implementing new practices and the fourth section examines professional development as it exists in the school system.

Section One: The Standards of Mathematical Practices

The eight Standards of Mathematical Practices detail a collection of skills that students are expected to acquire through their learning of the mathematical content standards. “These practices rest on important ‘processes and proficiencies’ with longstanding importance in mathematics education” (CCSS, 2010, p. 4). The content standards require students to acquire specific knowledge and skills and the practices require students to know how they use this knowledge and skills. The SMP are composed of two research based efforts that focus on suggested practices in the classroom. One component is NCTM’s five process standards, which are comprised of problem solving, reasoning and

proof, communication, connections, and representation. The SMP also include the strands of mathematical proficiency from the National Research Council's report *Adding It Up* (2001). These five strands include adaptive reasoning, strategic competence, conceptual understanding, procedural fluency and productive disposition. In its creation the SMP were placed into four categories which supported a higher order structure (see Chart 1). Similar to how the clusters and domains provide higher order structure to the mathematical content standards, this structuring process allowed a higher order design with the SMP. These four categories include: Overarching habits of mind of a productive mathematical thinker (SMP 1 & 6), Reasoning and explaining (SMP 2 & 3), Modeling and using tools (SMP 4 & 5), and Seeing structure and generalizing (SMP 7 & 8). According to Bill McCallum, one of the writers of the CCSMCS and the SMP, by providing structure to the SMP it helps teachers to make a stronger connection with the content standards and the SMP while avoiding "fruitless tagging exercises" (blog post, Tools for the Common Core Standards, 2011). According to Deborah Loewenberg Ball, (MSPnet Academy webinar, Learning to Teach the Common Core, 2011) teachers need to understand three crucial things to teach the SMP. First, teachers need an appreciation of how significant the practices are to learning the content. Second, they need to develop a confidence that all students can and must develop proficiency with the SMP. Third, teachers need mathematical knowledge for teaching (MKT) with respect to the mathematical practices.

Chart 1. This chart illustrates the higher order structure of the SMP



From Standards for Mathematical Practice document by Will McCallum University of Arizona (2011)

The Leading for Mathematics Proficiency (LMP) Framework (Bay-Williams, McGatha, Kobett, & Wray, 2014) has three components to support teachers in creating classroom environments that encourages the daily use of the SMP. The first component is the SMP in relationship to student outcome; meaning, what does the SMP expect students to be able to demonstrate while using the practices. The second component is a shift in teaching practices; the framework considers what shifts in teaching practices are necessary in order to provide students with the opportunity to demonstrate the mathematical practices. The last component in this framework is teaching skills; the LMP framework asks what knowledge or skills will enable and support a teacher in shifting classroom practices.

Providing opportunities for students to use higher level thinking skills requires teaching practices that make a connection with the content standards and the SMP. Based on NCTM teaching documents and research on classroom practices, Bay-Williams, et al. (2014), created seven shifts in classroom practice.

Shift *from* same instruction	*toward* differentiated instruction
Shift *from* students working individually	*toward* community of learners
Shift *from* mathematical authority coming from the teacher or textbook	*toward* mathematical authority coming from sound student reasoning.
Shift *from* teacher demonstrating "how to"	*toward* teacher communicating "expectations" for learning.
Shift *from* content taught in isolation	*toward* content connected to prior knowledge.
Shift *from* focus on correct answer	*toward* focus on explanation and understanding.
Shift *from* mathematics-made-easy for students	*toward* engaging students in productive struggle.

These shifts identified by Bay-Williams et al. can serve as a framework for eliciting teachers' viewpoints about important changes requires by the CCSS practices. These shifts provide teachers with an opportunity to evaluate where their teaching practices are on this spectrum and to consider how to change to teaching practices that better support students with the SMP.

Section Two: Teaching Practices that Support the Standards of Mathematical Practices

This section will examine what these suggested practices are and what they look like in the classroom. This study will consider what teaching practices teachers have implemented in their classroom, so it is important to understand if the practices teachers are using align with research suggested practices.

According to Kilpatrick et al. (2001) learning with understanding strengthens students' ability to organize material, encourages fluency, supports learning other related concepts, and increases retention of thoughts, ideas and skills. These authors believe mathematical proficiency refers to anyone who has learned mathematics successfully. Their report, *Adding It Up,* is compiled from relevant research on mathematics learning from pre-kindergarten through grade 8. The authors focused on a "more rounded portrayal of the mathematics children need to learn, how they learn it and how it might be taught to them effectively" (p. xiv). They describe mathematical proficiency as having five components or strands:

- conceptual understanding (actively building new knowledge from experience and prior knowledge),
- procedural fluency (accurately and efficiently carrying out procedures)
- adaptive reasoning (explanation and justification of answers- mathematical discourse)
- strategic competence (represent and solve mathematical problems), and
- productive disposition (ability to see mathematics as useful) (Kilpatrick, et al., 2001; NCTM, 2000).

These strands are considered interwoven and "represent different aspects of a complex whole" (p. 116). The rest of this section of the literature review will consider the importance of providing students with the opportunity to focus on Kilpatrick et al. (2001) mathematical proficiency strands and NCTM's five process standards as teaching practices that support the CCMCS and SMP.

Conceptual and Procedural Knowledge

Working from Byrnes (1992), Hiebert & Lefevre (1986) and Kieren's (1993) definitions of conceptual and procedural methods, Hallett, Nunes, and Bryant (2010) define conceptual knowledge as not "the memorization of separate nuggets of information but as the ability to see interconnections between knowledge" (p. 396). The intention of teaching conceptually is to support students' understanding of the procedural methods used to find the solution to the mathematical problem (Eisenhart, Borko, Underhill, Brown, Jones, and Agard, 1993). Combining definitions from these same researchers, Hallett, Nunes and Bryant (2010) consider procedural knowledge to be, "linearly executed and independent of meaning: an individual using a procedure should not need to reflect on what the elements implemented in the procedure mean" (p. 396). For example, having a procedural knowledge of division of fractions would require knowing or memorizing the process of the steps to complete in the algorithm, (i.e., first invert the divisor and then multiply the new fraction). When dividing fractions, a conceptual understanding includes the ability to create a visual representation of the division process and explain why the process of invert and multiply works.

Rittle-Johnson and Alibali (1999) believe children's conceptual understanding influences the procedures that they use. They also include the following ideas regarding children's conceptual knowledge and mathematical learning:

1. Children with greater conceptual understanding tend to have a greater procedural skill;
2. Conceptual understanding precedes procedural skill;
3. Instruction about concepts as well as procedures can lead to increased procedural skill; and
4. Increasing conceptual knowledge leads to procedure generation (p. 176).

These four ideas promote the importance of students' starting with a conceptual understanding in mathematics, which can then reinforce a procedural understanding. Kilpatrick, Swafford, and Findell, in *Adding It Up* (2001), refer to conceptual understanding as the ability to connect mathematical ideas to relatable contexts, connect new ideas to things they already know, and know more than isolated facts. Facts and methods learned with understanding are easier to remember and recreate if forgotten. Research supports this idea of conceptual understanding as the primary objective of mathematics instruction, but it also states the importance of including the development of computational skills (Hiebert, Carpenter, Fennema, Fuson, Wearne, Murray, Olivier, & Human, 1997) in order for students to have a deep understanding of mathematics.

The National Council of Teachers of Mathematics (NCTM, 2000), as outlined in the *Teaching Principle*, states that teachers need to continually increase their knowledge about mathematical content and pedagogy. It is important for teachers to understand how to teach

beyond computational procedures and provide students with the opportunity to use the standards of mathematical practices, when teaching the common core standards. The CCSS requires students to have a conceptual and procedural understanding of mathematics as well as the ability to justify their answers. The National Council of Teachers of Mathematics (NCTM) (2011) recommends the development of new approaches to teacher professional development and in development of teachers' mathematical content knowledge in order for teachers to model the mathematics practices of the CCSS. In light of the CCSS requiring students to have a conceptual understanding, professional development programs need to consider not only the mathematical content knowledge of teachers but their conceptual knowledge as well.

Adaptive Reasoning: Discourse during Math

Although the idea of focusing on children's mathematical thinking through discourse is not new, with the implementation of the common core mathematical standards and the standards for mathematical practice, it is becoming more prominent. Adaptive reasoning is one of the strands, which according to Kilpatrick, et al. (2001), promotes mathematical proficiency. Adaptive reasoning refers to the capacity to think logically about the relationship among concepts and situations with the ability to explain and justify reasoning. The mathematical practices expect students to have the ability to construct viable arguments and critique the reasoning of others. There is also the expectation for students to provide clear reasoning while communicating with others. These expectations raise the importance for teachers to provide opportunities for students to build these skills. It has been found that children as young as five years old have the ability to reason when the context is familiar and comfortable, the task is understandable and motivating, and they have sufficient

knowledge base of the context (Chapin, O'Connor, & Anderson, 2009; Kilpatrick, et al., 2001). Allowing students to talk with each other provides an opportunity to build a community of collaboration, where they can consider strategies and ideas from each other as well as support their own mathematical understanding (Franke, Webb, Chan, Ing, Freund, & Battey, 2009; NCTM, 1991).

The National Council of Mathematics (NCTM) (1991) proposes that when teaching mathematics, teachers should:

> Pose questions and tasks that elicit, engage, and challenge each student's thinking; listen carefully to students ideas; ask students to clarify and justify their ideas orally and in writing; decide what to pursue in depth from among the ideas that students bring up during a discussion; decide when and how to attach mathematical notation and language to students' ideas; decide when to provide information, when to clarify an issue, when to model, when to lead, and when to let a student struggle with a difficulty; and monitor students' participation in discussions and deciding when and how to encourage each student to participate (NCTM, 1991, pp. 3 & 4).

These can be new and challenging tasks for some teachers. As teachers learn to have a conversation with their students regarding their thinking, they then contemplate their students' mathematical understanding. It also allows teachers to determine what future lessons or conversations should entail (Franke et al., 2001). When teachers respond to children's explanations of their mathematical thinking, they must consider the strategies students use, and interpret the student's understanding or misunderstanding in order to provide a response that promotes a deeper knowledge of the concept (Jacobs, Lamb, and

Philipp, 2010). When exploring these strategies, Jacobs et al. (2010) report that noticing the complexity and details can provide insight into the students' understanding of the concept and support a teacher in deciding how to respond.

The Advancing Children's Thinking (ACT) framework (Fraivillig, 2001) offers the following suggestions when evoking students' solutions:

> Elicit many solution methods for one problem. Wait for and listen to students' descriptions of solution methods. Encourage elaboration. Use students' explanation as a basis for lesson's content. Convey an attitude of acceptance toward students' errors and efforts. Promote collaborative problem solving. Decide which students need opportunities to report (p. 456).

When the teacher asks questions such as, "Did anyone solve this problem a different way or use a different strategy?" students see there may be a variety of solutions to one problem. These probing type questions are a significant part of promoting children's thinking. Teachers can provide "wait time" which offers students time to think, process, as well as encourages a more thoughtful response. When teachers or other students ask for clarification in a student's response, it often provides other students with more details of that student's thinking. Having students discuss and show their strategies can provide an opportunity to guide other students through the content lesson. Including time for students to work together creates an environment of respect and the ability to express their thinking in a smaller group setting (Fraivillig, 2001). When teachers include the SMP in their teaching, rather than ending a discussion by providing the right or expected answer, students' responses become the focus of the discussion. For this to happen,

> a teacher must be skillful at posing questions that challenge student thinking, listening carefully to students' ideas, rephrasing students' explanation in terms that are mathematically more sophisticated, deciding when to provide information, and orchestrating class discussions to ensure participation by all students (Peressini, Borko, Romagnano, Knuth, & Willis, 2004, p.79).

Represent and solve mathematical problems (Strategic competence) & ability to see mathematics as useful (Productive disposition)

Productive disposition and strategic competence are the next two mathematical proficiency strands considered as important practices in the classroom. Productive disposition refers to the ability to see mathematics as useful and to see that learning mathematics is worthwhile. As students become proficient in the other strands of mathematical proficiency they view themselves as mathematical learners; then they become more positive about math which builds higher productive disposition. Strategic competence "refers to the ability to formulate mathematical problems, represent them and solve them" (Kilpatrick, et al., p. 124). Strategic competence does not consider the typical textbook problem-solving exercises that require just using computational skills, but considers problems that relate mathematics to real-world situations (Stanic & Kilpatrick, 1988). According to Cai (2003), with the teacher's guidance students are active participants in their learning through problem-solving situations.

The Institute of Education Sciences (IES) (2012) published a practice guide which offers five evidence-based recommendations to improve mathematical problem solving in grades 4 through 8. The first recommendation is to prepare routine and non-routine

problems in whole class instruction. When preparing these problems consideration should be given to context or language issues students may have and consider students' mathematical content knowledge. The second recommendation is to assist students in monitoring and reflecting on the problem-solving process. It is suggested that teachers provide students with prompts, models, and opportunities to hear other students' thinking to help them monitor and reflect on their own problem solving process. Recommendation three suggests that students are taught how to use visual representations that are appropriate, use discussions to support students' visually representations and provide opportunities to convert the visually representation into mathematical notation. The fourth recommendation calls for teachers to expose students to multiple problem-solving strategies, allow students to compare and share a variety of strategies. Recommendation five suggests students explain the process they used to solve the problem and support students to make sense of algebraic notation. The practice guide includes the following four steps for teachers to incorporate into their lessons which support the five recommendations: 1) consider appropriate problems and visual representation that align with the students' needs; 2) teach students how to use the visual representation and how to convert them to mathematical notation; 3) provide a list of prompts to support student monitoring and reflection of the problem solving process; and 4) ask students to share and compare multiple strategies for solving problems. Although a teacher may not be able to include all four steps into each lesson, it is recommended that they are considered during the planning process.

According to National Council of Teachers of Mathematics (NCTM) research brief, 2010, the term "problem solving refers to mathematical tasks that have the potential to provide intellectual challenges for enhancing students' mathematical understanding and

development" (p. 1). For students to make a connection between mathematics and the real world they must have a broad conceptual understanding of the mathematics involved to solve the problem. When problems require students to make this connection they are compelled to relate what they know about the problem and mathematics. Teachers can facilitate students through this process but students' understanding occurs as a result of learning and reflecting through problem solving (Lambdin, 2003). Lambdin sees six benefits for students when they learn with understanding: 1) it is motivating, 2) promotes more understanding, 3) helps memory, 4) enhances transfer, 5) influences attitudes and beliefs and 6) promotes the development of autonomous learners.

While providing students with the opportunity to discuss their mathematical thinking and using problem solving task as a catalyst has proven to be a meaningful teaching practice, it is a difficult practice for most teachers. Hiebert (2003) writes, "allowing mathematics to be problematic for students requires a very different mindset about what mathematics is, how students learn mathematics with understanding, and what role the teacher can play" (p. 54). Sakshaug and Wohlhuter (2010) immersed teachers in an action research study that considered the challenges and successes of teaching through problem solving. This project occurred during a graduate course titled, *Teaching Elementary School Mathematics,* with forty-one teacher participants. Of the forty-one teachers, five teachers were pre-kindergarten and kindergarten teachers, one middle-school Spanish teacher, one secondary mathematics teachers, one science teacher, seven teachers who were not yet teaching in their own classroom yet and 26 other teachers who taught in first through sixth grade. Two text books were used for the course, NCTM's *Principles and Standards for School Mathematics,* and *Children Are Mathematical Problem Solvers* (Shkshaug, Olson, &

Olson, 2002). The second book, (Shkshaug et al. 2002) provided non-routine problems to solve, questions to ask students while they solve the problems, and samples of students solutions. Each graduate class provided participants with an hour of problem solving, group discussion of the process and solution of the problems, and whole class debriefing solutions. Other topics discussed included where the math was in the problem, what challenges occurred and how students may approach the problem.

As part of the action research aspect the teachers were expected to pick two problem solving problems they previously solved or read about during the course and present it to their students on two different occasions. Arrangements were made to support those participants who did not have their own classroom. After each lesson the participants were asked to address the following prompts: 1) why I chose this problem; 2) children worked: alone or with others; 3) what I did to present the problem; 4) what the children did when they were solving the problem; 5) what the children learned; 6) what surprised me; 7) what I would do differently if I taught this problem again; and 8) how the problems were like/unlike what the authors reported in the class text. Other data collection included notes taken by the professor during each class session and project discussion as well as an end of the course written reflection by each participant. The following results were recorded:

Successes	Challenges
A. Teachers became comfortable with being a facilitator. B. Teachers maintained the integrity of the problems when presenting them: a. Avoided modeling how to solve the problems; b. Encouraged students of finding ways to solve problems and c. Learned how to guide discussion. C. Teachers became more confident about their abilities to solve the problem.	A. Teachers successfully used a problem-solving approach with one problem but not with the other. a. Used groups for one problem but not both b. Used groups but provided strategies for students to use to solve the problems c. Unsure how to facilitate students during the process

The researchers concluded the teachers made progress in moving their teaching toward using more problem solving. These researchers had some questions about the future of these participants: 1) would they continue to use problem solving to support students' learning, 2) would they continue to believe their students can learn through problem solving; or 3) would they discontinue what they learned and fall back to their traditional teacher-directed style of teaching?

Sakshaug and Wohlhuter's (2010) study considered one challenging yet beneficial method to promote students' mathematical thinking and understanding. The results provide information on the difficulty teachers face as they implement change in their teaching practices. Even though the teachers noticed the students' learning from using a problem solving task, these authors were uncertain if teachers would continue to use this method once they were away from the study. The teacher's role in problem solving is multifaceted. It requires teachers to pick a relevant problem solving task, consider the presentation of the

problem, and anticipate challenges student may have solving the problem. Teachers must also facilitate the task by asking questions as students are working and during the sharing process to ensure students see a variety of solutions. Despite PD that has a problem solving focus, this different mindset can be difficult for teachers to overcome alone. The California Common Core State Standards (CCSS) Implementation plan states in order to support every student in meeting the CCSS expectations teachers must know and uses a variety of instructional strategies and understand the expectations of what students need to know and be able to do. It also suggested that every educator have an opportunity to participate in high quality professional development in order to be prepared to offer the rigor and depth of knowledge require by CCSS. In order for students to learn in ways intended by the Common Core mathematical standards and mathematical practice it is crucial for teachers to make a shift in their teaching practices.

Section Three: Supporting Teachers in the Implementation of New Practices

While the CCSS focus is on teaching for critical thinking, research (Banilower, Boyd, Pasley, & Weiss, 2006; Boaler, 1998; Byrnes, 1992; Ma, 1999; Weiss & Pasley 2004) shows that most classroom instruction focus is on rote or procedural teaching methods. Teachers have to learn new ways to teach. These new teaching practices may be ways they likely have never experienced themselves and that they rarely see their colleagues engage in. Research shows the greatest challenge for teachers does not simply come in acquiring knowledge of new strategies, but in implementing those strategies in the classroom (Center for Public Education, 2013). A study conducted by Joyce and Showers, (2002) found on average it takes teachers 20 different opportunities of practice to master a new skill.

In his effort to create a more effective professional development program that promoted a change in teachers' perspectives and practices, Guskey (2010) created a model of teacher change. The first step in this model is to provide PD. From this the idea is that teachers' practices will change. Next, teachers will see a change in student learning outcome and from this there is a change in teachers' beliefs and attitudes. According to Guskey it is not necessarily the PD that is the catalyst which changes teachers' beliefs and attitudes, but the change is motivated by student learning outcomes. If teachers see a positive change in students' learning outcome when implementing new teaching practices, they are likely to continue to use these practices. If there is no change in students' learning outcome, teachers are likely to abandon these new practices. Student learning outcomes can include higher scores on quizzes, exams, or standardized assessments, or they can include a change in classroom behavior such as, motivation to learn or attitudes towards school. When considering the implications for PD Guskey believes there are three principles that derive from this model.

The first principle is to recognize that change is a gradual and difficult process for teachers. Change requires extra time and effort, which can add to the teachers' workload. When teachers are unsure they can make new practices or procedures work they are afraid to risk failure and implement them. Teachers are also cautious to abandon practices they have previously used and are comfortable using. As teachers implement change at different rates and fidelity, it is important to offer support and collaboration during this time. The second principle is to ensure that teachers receive regular feedback on student learning progress. This model's premise is that teacher change occurs after there is an improvement in students' learning so teachers must have the opportunity to notice student growth and

development. This progress can be monitored by formative assessments and consider students' participation and attitudes during the lesson. The third principle acknowledges it is crucial to provide continued follow-up, support and pressure. Guskey believes "of all aspects of PD, sustaining change is perhaps the most neglected" (p. 388). Support is needed to help continually move those teachers who may struggle with the implementation of new practices forward, while pressure may be needed to move teachers who may be reluctant to implement any changes. Overall it is important that teachers see changes as a process that takes time. According to Fullan (2001) a common component in educational change is an "implementation dip" (p. 40). This dip occurs as a person starts to question their ability to acquire the new skills and the new understanding expected for this change. "People feel anxious, fearful, confused, overwhelmed, deskilled, and cautious" (p. 40) as they deal with letting go of prior practices. When teachers are presented with information that contradicts existing practices and beliefs while at the same time promote new practices, teachers may feel vulnerable as they question the effectiveness of their old practices.

Le Fevre (2013) conducted a study considering teachers' perception of risk when implementing a literacy change initiative (LCI). This study examined two questions: (1) what do teachers perceive as risks in the process of educational change? And (2) what makes something a risk in an educational setting? The data collection occurred at one school site that was known for its lack of change in teaching practices over many years. An invitation to participate in the research was extended to 12 teachers of the 24 grade-level teachers at the school. In order to provide a diverse sample of participants, consideration was given to grade level, teaching experience and gender. Data collection consisted of interviews, informal observation and copies of materials associated with professional development from

the LCI practices. Analyzing student progression in literacy, the LCI practices focused on supporting teachers in using this information to inform their teaching practices. The LCI program provided teachers with staff presentations, discussion groups, evidence-based classroom practices and individualized support. Through the interview process the researcher found three actions that 11 of the 12 teachers perceived as high-risk (1) de-privatizing their practice (observing and being observed by other teachers while they taught a lesson); (2) reducing their pedagogical dependence on textbooks (LCI suggested providing text that is based on the students' needs); and (3) increasing student voice in the classroom (providing students with opportunities to share their literacy thoughts and understanding of material). Although these three actions were important components of LCI, these teachers could not overcome the risk they felt to implement these practices. The twelfth participant implemented the changes and strategies suggested by LCI and indicated no perceived risk involved with these changes. The researcher found this participant and another colleague worked closely together to implement the necessary changes. This participant mentioned she felt the changes were backed by solid research and necessary to support her students.

Le Fevre (2013) suggests in order for teachers to overcome their fear of the risk involved in change, they must have a supportive school environment. It is "important that concerns are shared and listened to, because this can help resolve conflict and promote a sense of fairness and, perhaps by extension, empathy and trust" (p.63). Providing opportunities for teachers to discuss and address these concerns can lead to a willingness to take risks. Facilitators of professional development need to know and understand the challenges teachers face as they implement an expected change in pedagogy.

Section Four: Professional Development

In 2013, a survey regarding the progress and challenges of the adoption of the common core standards was conducted by the Center on Education Policy. Thirty-nine out of the 45 states that had adopted the CCSS responded to the survey regarding the progress and challenges of the adoption. Nearly all of the states (36 out of 39) agreed or strongly agreed that implementing the Common Core would require fundamental changes in mathematical instruction. While PD is a key component in supporting teachers in changing teaching practices, Jenkins and Agamba (2013) report "the missing link in the CCSS initiative is professional development to support implementation" (p. 70).

This section will review the recommendations of The National Academy of Education and The National Staff Development Council, as important components of quality professional development, then consider the outline of suggestions from a more recent report regarding the implementation of the Common Core Standards for Mathematics and PD from North Carolina State University and lastly provide a rationale for this research project.

What Research Says About Quality Professional Development

In 2009, The National Academy of Education (NAED) published four recommendations to improve teacher quality. One of these recommendations focused on the need for quality professional development. The report states "like their students, good teachers are learners and they need high-quality professional growth opportunities throughout their careers" (p. 6). The publication includes five significant traits of effective professional development for content teaching:

1. It focuses on deepening subject matter knowledge specifically for teaching, including understanding how students learn and the specific difficulties they may encounter in mastering key concepts.
2. It involves enough time for significant learning (for example, a course or program of 40 or more hours distributed over 12 or more months)
3. It is coherently related to what teachers are being asked to do and builds on what teacher already know and are able to do.
4. Educators are actively engaged, rather than just listening to a lecture or watching a demonstration.
5. Teams of teachers from the same school participate and learn together, enabling them to support each other in using what they have learned (p. 6).

The National Staff Development Council (NSDC) published *Professional Learning in the Learning Profession: A Status Report on Teacher Development in the United States and Abroad* in 2009, and reported that well-designed professional development can, "help teachers master content, hone teaching skill, evaluate their own and their students' performance, and address changes needed in teaching and learning in their schools" (p. 7). The NSDC reports the following guidelines for well-designed professional development:

1. Professional development should be intensive, ongoing and connected to practice.
2. Professional development should focus on student learning and address the teaching of specific curriculum content.
3. Professional development should align with school improvement priorities and goals.

4. Professional development should build strong working relationships among teachers (p. 9-11).

A more recent publication that considers PD and the Common Core Standards comes from a North Carolina State University report, *Supporting Implementation of the Common Core State Standards for Mathematics: Recommendations for Professional Development* (2011). This report considers the previously mentioned NSDC guidelines as important considerations when planning PD and offers the following 9 suggestions:

1. PD provides opportunities for teachers to engage with the CCSSM content and the CCSSM practices in a focused and integrated way.
2. PD materials are needed that explicitly address the content and practices of the CCSSM and provide vivid images of teaching and learning that are consistent with CCSSM.
3. PD takes into account existing knowledge about effective ways to organize learning experiences for teachers of mathematics.
4. Programs of PD provide a continuous and coherent set of experiences in which practicing mathematics teachers engage over an extended period of time.
5. PD uses expert facilitation to ensure teacher learning of CCSSM at scale.
6. Strong programs of PD target a variety of role groups with the education system and attend to the professional needs of each group as the system builds capacity at all levels.

7. Members of the general public need to be apprised on how the CCSSM will impact instruction and learning in our nation's classrooms.
8. PD programs are regularly assessed to provide formative information for program improvement and revision and to establish the effectiveness of the programs.
9. PD consortia are needed to oversee and improve the role PD plays in successful implementation of the CCSSM (p. 4).

Embedded within these 9 recommendations, this report also suggests that teachers need experiences with the CCSSM content and practices as learners before implementing them in the classroom. This report considered the time limitation of school districts and provided some suggestions, but did not consider the financial limitation. When considering teachers' time and availability they suggested that PD can be delivered in a variety of methods which can include face-to-face, virtual meetings, job embedded, and within-school and outside of school. They also suggested that PD needs to address promising practices such as discourse, students' mathematical thinking, and cognitively demanding tasks.

These publications focus on what research outlines about quality professional development regarding teachers' practice and student learning and offer recommendations that are very similar. While these are very important components in providing quality PD, they do not support the challenges school districts face; contrary to these recommendations, 57 percent of U.S. teachers surveyed reported they have no more than 16 hours of professional development and collaboration that occurs is weak (NSDC, 2009). Professional development that supports the implementation of the CCSS and the SMP need to consider

the best teaching practices for these standards, how to support teachers in acquiring these teaching practices, and what, if any, classroom support is needed in the implementation of these teaching practices. Traditional PD that provides a 'one size fits all' is no longer appropriate for the new demands the CCSS and SMP place on teachers.

Rationale

Research suggests that effective professional development must be meaningful, engaging and ongoing. It needs to focus on knowledge specifically for teaching, as well as provide support to teachers in the classroom that address specific challenges of making a shift in teaching practices. The CCSS and the Standards for Mathematical Practices all require a new look at professional development. Districts need to create opportunities for teachers to build and expand their teaching practice in order to help students build and expand their ability to think critically and conceptually. Consideration needs to be given as to best practices in supporting a teacher from teaching primarily procedural methods in mathematics to a teacher who can support a students to make sense of problems and persevere in solving them. Teachers also need to know how to support students in constructing viable arguments for their answer and explain the strategy or strategies they used to solve the problem. These changes to teaching more in-depth mathematics and meeting the CCSS expectations will not come easy for some teachers.

As reported by Jenkins and Agamba (2013) professional development that supports the implementation of the CCSS is the missing link. While there are many lists of things that need to be considered during the implementation process of the CCSS, there is a lack of research regarding PD that provides proven implementation practices in this area and the

importance of including teacher voice in this process. This research project will add to this missing link by describing the implementation process of the SMP used by teachers, what added support teachers feel they need as they continue to work on making shifts in their teaching practice and how PD has supported them in this process.

CHAPTER THREE- METHODS

The purpose of this study is to add to the limited body of research regarding the implementation strategies and challenges teachers are facing as they transform their teacher practices to support the Common Core Math Standards and the Standards of Mathematical Practices. In order to understand how teachers are dealing with these new standards, this study used a semi-structured interview process. This process allowed the researcher to have a standard set of questions, yet gave the ability to explore the views, experiences, beliefs, and motivations of the participants individually. This project considers the following questions to achieve a deeper understanding of teachers' experiences as they develop the needed skills in this implementation process.

1. What are teachers' perspectives of the Common Core Standards of Mathematical Practices?
2. What happens when teachers start to implement the Common Core Standards of Mathematical Practices?
3. How has professional development supported teachers through this process?

Site Selection

The data collection is from a small K-8 school district located in Ventura County, California. For the purposes of this study it will be referred to as the Orchard School District (OSD). Total enrollment for OSD's 11schools as of August 28, 2013, was approximately 6,600 students. There were seven K-5 elementary schools, two K-8 sites and two 6^{th} – 8^{th} grade middle schools. Recent scores for the district's elementary students in the California

Assessment Program, addressing five areas of educational concern, were at the high end of the county scores and well above state scaled scores in each area. Three of the eleven schools received Title One funds and at the time of this study, one of these three schools is in Program Improvement Year Two under the provisions of No Child Left Behind (NCLB) act. There were approximately 400 K-8 certificated teachers employed by the district. Kindergarten through 5th grade teachers all participated in a series of four required PD programs presented by the district over the course of eight months. Each of these PD's addressed the SMP and teaching practices that support the incorporation of these standards into teaching mathematics.

Participant Selection

Participants consisted of 12 kindergarten through fifth grade teachers. In order to provide a diverse sample of participants, purposeful sampling was used. The nine elementary schools were divided into groups by the student population at each site, and then by grade level, with two teacher volunteer participants from each category (see Table 1). This sampling allowed the researcher to gather insight from participants that teach at the lower achieving schools in the district as well as the high achieving schools based on state testing results.

Table 1

School Sites by Student Population

	Student Population 350-400 (3 school sites)	Student Population 401-600 (3 school sites)	Student Population 601-700 (3 school sites)
Kindergarten – 2rd Grade	2 participants	2 participants	2 participants
3rd Grade – 5th Grade	2 participants	2 participants	2 participants

Three of the district school sites had a population of less than 400 students and were considered the district's small school sites. Two of these small school sites were Title One schools. Three of the school sites had a population above 400 students, but less than 600 students and were referred to as medium school sites. One of these sites was listed as a Title One school. The last three school sites were considered large schools with a population of above 600 students.

During district grade level meetings in the fall of 2014, the researcher was introduced to teachers and allowed to explain the research project. There were 165 K-5 teachers in the district and 30 of these teachers volunteered to participate in the study by completing a sign-up sheet which provided school site, grade level, and contact information. These volunteers were divided into categories based on the student population of the school site and grade level where they taught during the data collection. The school sites with the higher population of students also had more teachers on those sites, which led to a higher number of volunteers willing to participate from this category. There was also a lack of significant volunteers at the small population school sites. This disparity in volunteers

created a limitation on the number of participants for this study. In order to have an equal representation from each category, two participants were randomly chosen from each school size and grade level category. Prior to the interview process, the participants had the opportunity to review the interview questions and to decline their participation in the study. All 12 participants agreed to be interviewed. Participants included: Small School Sites- a kindergarten, first grade, and two third grade teachers; Medium School Sites- one first, second, fourth, and fifth grade teacher; and the Large School Sites- two first grade teachers, a fourth, and fifth grade teacher (see Table 2).

Table 2

Participants' Demographics

	Student Population 350-400 (3 school sites) Small	Student Population 401-600 (3 school sites) Medium	Student Population 601-700 (3 school sites) Large
Primary Grade Level (K-2)	Kindergarten & 1st Grade Teachers	1st & 2nd Grade Teachers	Two- 1st Grade Teachers
Upper Grade Level (3rd-5th)	Two- 3rd Grade Teachers	4th & 5th Grade Teachers	4th & 5th Grade Teachers

The participants' years of teaching experienced varied from 2 years to 30 years. To protect their identity and ensure confidentiality of the participants, a connection between their grade level and the number of years teaching experience will not be referred to during this study. Participants were asked to sign a consent form allowing the data collected to be used in this study and were made aware of their rights to withdraw from the project at any time prior to

publishing of the research. The researcher stipulated that it would not be possible to eliminate all confidentiality concerns, as all participants were known to the researcher. All documents, including signed permissions, and transcribed interviews were kept secured by the researcher until it was time for them to be destroyed.

Researcher

As the researcher on this project I was the sole author of this study and a doctoral candidate in the Education Department. I also worked full time in a public school district in Ventura County. My experience in a public school district included 14 years as a classroom teacher, two years as a teacher on special assignment, and one year in the curriculum department as the coordinator of curriculum and instruction. I also had three years of experience as a part-time instructor at a large local public University in the teacher education program. These experiences provided a connection and level of trust with the participants of this study. I knew all of the participants, but had no supervision responsibilities for any of them. My familiarity with the participants provided more willingness for teachers to participate in this project.

Data Collection

Timeline

This study gathered data from teachers who participated in a series of PD sessions over a period of eight months during the 2013-2014 academic school year. The timeline of the PD sessions these participants attended is as follows: Session 1: October 2013, Shifts in Classroom Practices Self-assessment; Session 2: November 2013, Mathematical Discourse;

Children's Literature; Math Journals; Session 3: January 2014, SMP 3 Construct Viable Arguments & Critique the Reasoning of Others; Session 4: March 2014, Content Standards. The Orchard School District implemented the Common Core Standards during the 2014-15 school year and the curriculum department allowed each site administrator to oversee the implementation process. The data collection occurred from October-November 2014.

Interview

The 12 participants were interviewed individually at a time and location of their choosing. Most of these locations included the teacher's classroom, after school hours. The researcher assured these environments were quiet and provided an opportunity for quality recordings of the interview process. The duration of the interview varied for each participant. The shortest interview lasted about 45 minutes and the longest interview ended just after an hour and fifteen minutes. The length of the interview was influenced by the length of the participants' comments, and the amount of time it took them to process the questions. The interviews took place approximately three months into a new school year for these teachers and consisted of 13 questions (See Appendix for all interview questions).

The interview questions attempted to elicit an account of the teachers' perceptions of the CCSSMs and the SMPs. The goal of the interview was to provide the teachers with the opportunity to step back and reflect on the implementation of these new standards and how this process may have required them to make changes in their teaching practices, while at the same time providing the researcher with data to support the research questions for this study. In order to ease the participants into the interview, the first questions were easy to answer. These first questions included the grade level the participant taught, as well as the

number of years they had been teaching. Subsequent questions asked participants to address how and when these standards had been used in their classrooms and how these standards might have required them to make changes in their teaching practices. Participants were also asked to consider the role that PD has played during the implementation process of the CCSSMs and the SMPs.

The researcher allowed the natural path of conversation to develop during the interview and used probing questions when needed to allow participants to expand on the answers and comments. The interviews were digitally recorded using a voice recorder on a tablet device and a phone as a backup redundancy measure in case of equipment malfunction. The researcher took minimal notes as not to distract the participant. This allowed a more natural conversation to develop. Field notes were taken during the interviews for organizational and reference purposes. The interviews were transcribed at a later time.

Data Analysis

Each participant was interviewed using a list of predetermined questions (Appendix) with the opportunity to ask clarifying questions. Participants were encouraged to express their thoughts, feelings, and to provide the researcher with a deep understanding of what they were experiencing. The interviews were recorded and transcribed. Once the transcription was completed the interview questions were divided into three categories based on how the question supported answers to the three research questions. Across the participants' responses to each interview question I looked for relationships and patterns with regards to their response, years of service, school location and grade level. When no

relationship or patterns related to these variables were found within the responses, I coded responses for common thoughts and ideas. In the next phase of this process the codes were reviewed for common themes. Through this process two major themes developed; Participants' positive implementation perspectives and Implementation expectations, challenges, and concerns. Each theme was divided into more detailed categories. The structure of these two themes will be discussed further in the next chapter.

Theme One - Positive Implementation Perspectives was divided into two sub-categories:

1. Participants' perspectives regarding the CCSSM and SMP;
2. Participants' perceptions of positive changes in their teaching practices; and
3. Participants' observations regarding students' mathematical progress in using and learning the CCSSM and SMP.

Theme Two- Implementation Expectations, Challenges, and Concerns were divided into two sub-categories:

1. Challenges and concerns aligned to the classroom with the focus on how these may affect the teachers as well as the students; and
2. Outside influences that hinder or support the implementation process.

CHAPTER FOUR - FINDINGS

Background

During the 2013-14 academic school year, districts across the state of California anticipated the Department of Education suspending its current State Achievement test (STAR) in order to provide a trial run of the Common Core Standards Assessment using the Smarter Balanced Assessment Consortium testing system. Districts across California were searching for ways to support teachers in the implementation process of the CCSSM and the SMP. The OSD decided to use this school year to move forward with professional development on the CCSSM. Through a teacher leadership team, the decision was to focus on the SMP and finish with a review of the math content standards. Like most school districts OSD believed the content area of mathematics, along with the implementation of the SMP, would require teachers to make a bigger shift in their teaching practices than the Common Core English Language Arts Standards.

It is also important to note that quality math curriculum had been a continual debate with the introduction of the Common Core Standards. While the state of California provided districts with an approved list of published math curricula, many districts and teachers found that the curricula poorly met the rigor expected with the Common Core standards. Teachers were reluctant to make a seven- year commitment to these materials. The Orchard School District, with the recommendation of a team of teachers, decided to use a Common Core aligned math curriculum, created and posted online by another state. This material was piloted by a selected team of teachers during the 2013-2014 school year and was determined to be a viable alternative to purchasing material from a publisher. All participants in this

study were using this material for the first time as the main source of common core aligned math curriculum for the 2014-15 school year.

Professional Development Provided

This study gathered data from teachers who participated in a series of PD sessions over a period of eight months during the 2013-2014 academic school year. All of the PD occurred during the teachers' scheduled work day and was mandatory for all teachers to attend. Each PD varied in length from two to five hours**.** All twelve of the participants from this study attended these required professional development opportunities. The focus of this PD explored teaching practices that support the Standards of Mathematical Practices. The format of these PD provided opportunities for teachers to explore new ideas and concepts using a more conceptual approach to learning. The district's goals for the PD sessions were for the teachers to be active participants, to provide teaching practices and activities that aligned to the Common Core Standards and the Standards of Mathematical Practices and more importantly for teachers to have a deeper understanding of these standards. These were essential goals, as research in PD explains it is important for educators to be actively engaged in their learning (NAED, 2009), and that PD is connected to their teaching practices (NSDC 2009). Facilitators modeled teaching practices that support the SMP while providing opportunities for small group or partner conversation, "hands-on" problem solving activities, and when possible teachers viewed videos that provided a look into a classroom using the SMP. The PD sessions aligned with two suggestions from The North Carolina State University report, *Supporting Implementation of the Common Core State Standards for Mathematics: Recommendations for Professional Development* (2011). First, the report suggest that teachers need experiences with the CCSSM content and practices as learners

before implementing them in the classroom, and the Orchard School district provided the PD one year prior to the implementation of these standards. Second, the report suggested that PD needs to address promising practices such as discourse, students' mathematical thinking, and cognitively demanding tasks. The OSD PD sessions addressed these significant topics which will be further discussed in the next paragraphs. Thus, this district provided a good context for studying the impact of professional development on how teachers understand and implement the SMP standards. See Table 3 for an overview of the professional development provided by Orchard School District.

In the first PD sessions participants reviewed *Shifts in Classroom Practice Self-Assessment* (Bay-Williams, McGatha, Kobett, & Wray, 2014). During this time the participants considered the suggested shifts in teaching practices that support the common core mathematics standards and the standards of mathematical practices. Participants also had an opportunity to define the SMP and consider what these practices looked like in the classroom. Participants viewed videos and discussed how to build and promote students' conceptual understanding, support students in explaining and justifying their thinking and answers, as well as using drawings and physical models to develop strategic competence.

The second PD session was divided into three sections. Each section focused on a different teaching strategy and how these strategies promoted the use of the SMP. These strategies included mathematical discourse through the use of math talks/number talks, the use of literature, and the use of math journals during problem solving tasks. During the focus on mathematical discourse session participants viewed videos that showed teachers interacting with students during a whole class discussion around different strategies the students used to solve a particular problem. This process is often referred to as math talks or

number talks. It is during this type of discourse teachers can learn if students have an understanding of a concept or if they have any misconceptions. The videos provided the participants the opportunity to see different types of questions the teacher asked the students, and how these questions promoted students' mathematical thinking using discourse. The next section of PD explored how using children's literature could stimulate students' imagination and motivate them to think and reason mathematically when presented with a problem to solve from the story. When using children's literature to explore math concepts, it often allows the opportunity to make a connection between these two content areas. Participants were introduced how they could take a known children's literature book and make a mathematical problem solving task for their students. The last section of this PD considered the use of math journals and how they provided students with the opportunity to incorporate writing into mathematics. A math journal can be used to help students stretch their thinking, introduce writing into math time, and provide an avenue for students to explore different ways to solve problems. Participants addressed how using math journals allows students to show written strategies, and how it supports students in the use of representation (drawings). At the same time, discussion considered how students could use this recorded work as a reference when explaining their thinking to others.

The third PD session examined the third SMP, construct viable arguments and critique the reasoning of others. This PD took a deeper look into what this SMP looks like in the classroom. Participants watched videos of the roles teachers and students play while incorporating this practice. Participants were then encouraged to discuss with other same grade level teachers what benefits and challenges they saw in strengthening students' use in constructing viable arguments and critiquing the reasoning of others.

The last and fourth PD moved the participants to the common core mathematic content standards. This PD focused on how these content standards are grouped into major, supporting, and additional clusters. These clusters provide teachers with an understanding as to which standards require the majority of their teaching time in order to meet the expectations of the standard. The major cluster requires greater emphasis based on the depth of ideas than an additional cluster. The standards marked as major clusters also require more teaching time in order to meet the SMP. It is the major clusters that provide the best opportunity to incorporate the SMP.

Table 3

Professional Development Provided by the OSD

First PD	Shifts in Classroom Practices Self-Assessment
Second PD	1. Mathematical Discourse 2. Using Literature to teach Math Concepts 3. Math Journals to support Problem solving skills
Third PD SMP #3	How to encourage mathematical discussion in the classroom; viable arguments, & critiquing the reasoning's of others
Forth PD	Reviewed the CC math content Standards: Major, Supporting & Additional Clusters

Identifying Themes

During the initial evaluation of the findings consideration was given to the participants' responses, the size of the school site in which they taught and the number of years of service. I did not find any relationship or patterns between these variables. I determined that not reporting the teachers' years of service along with the grade level in these findings provided an added level of confidentiality. In this chapter, participants will be referred to only by the grade level in which they taught. The school district in which they work for will be referred to as the Orchard School District (OSD).

Theme One: Positive Implementation Perspective

One of the essential questions of this study considers, "What are teachers' perspectives of the Common Core Standards of Mathematical Practices?" According to Deborah Loewenberg Ball (2011), one of the three things teachers need to understand in order to teach the SMP is an appreciation of how significant the practices are to learning the content. At the time of the interview process the teachers had knowledge of the CCSSM and the SMP through district professional development and they were in the early stages of implementing these standards and practices in their classrooms. This section will examine:

(1) Participants' perspective regarding the CCSSM and SMP;
(2) Participants' perception of positive changes in their teaching practices; and
(3) Participants' observations regarding students' mathematical progress in using and learning the CCSSM and SMP.

Participants' Perspectives Regarding the CCSSM & SMP

Ten of the twelve teachers provided responses in regards to "liking or loving" the Common Core Mathematical Content Standards and the Standards of Mathematical Practices. Teachers agreed that the SMP required students to think more deeply about mathematics than has been required in the past. A third grade teacher stated, "I think they are a good shift because it is making kids think, able to problem solve and use their math in real world settings; where before it was rote memorization and drills." A fifth grade teacher expressed thoughts along the same lines and said, "I like the idea behind getting them to think about what they are doing rather than them doing the process without understanding the steps and I like the increase of rigor for the students." One of the newer teachers stated,

> I'm a big supporter of the Common Core Math Standards and the Standards of Mathematical Practices. I feel like it helps my students think about what they are doing. Not just memorize the math, but actually know why we are doing certain procedures. It's challenging for my students, but I love it! It's like a puzzle and I see light bulbs go on. So it's challenging as a teacher, but I feel it's what my students need in order to be successful later on.

While the majority of teachers had positive responses to the common core math standards and the standards of mathematical practices, two of the twelve teachers stated that it was too early to tell what they thought of the new standards and practices. Both of these teachers taught at the primary level and expressed they were just not sure how the SMP should look at the grade level they teach. One of the teachers said, "I think we're all learning. Me personally, I'm still trying to get a grasp on what it is and every day I feel like I'm learning along with the students."

Participants' Perception of Positive Changes in Their Teaching Practices

The most common change in teaching practices for these teachers concentrated in the area of providing more opportunities for students to share their thinking and/or provide more opportunities for partner or group work. When discussing if the implementation of the CCSSM and the SMP have required them to make changes in their teaching practices a first grade teacher expressed,

> It's [teaching] completely different then the way I used to do it. I pose a lot of open ended questions and I encourage them to talk to one another. I will give them materials, you know hands on materials and I will pose a question to them or give them an activity and let them go and work through it. I will circulate and talk to them. I have them do much more of the work and the talking. And more hands on exploration opposed to me doing the talking; a lot more of them and a lot less of me.

A third grade teacher said, "Definitely having the kids almost teaching each other. We talk about that a lot like, what if you had to teach this to a first grader; how would you explain it?" A fifth grade teacher shared, "The biggest thing I think we've done is the critiquing the reasoning of others. We have worked on providing viable arguments, showing your work, and asking a lot of questions. We also have to think about what are the right questions to ask. This process has been the biggest shift in our class."

When considering which SMP participants felt they were incorporating in their teaching during the implementation process, high usage was recorded in four of the eight practices: (1) MP. 1: Make sense of problems and persevere in solving them; (2) MP.3: Construct viable arguments and critiques the reasoning of others; (3) MP.4: Model with

mathematics; and (4) MP.5: Use appropriate tools strategically. These four SMP were the main focus in professional development offered by the school district in which these participants worked and all twelve of the participants in this study had attended these professional development opportunities. Interestingly, none of the participants reported incorporating MP.7 (Look for and make sense of structure) or MP.8 (Look for and express regularity in repeated reasoning) in their teaching. A fifth grade teacher said "I have to think about these more, while the others [SMP] come more naturally to me." A kindergarten teacher expressed concern on how to get students to see structure and repeated reasoning in these early stages of mathematics. Table 4 below shows the SMP, the number of participants that reported being comfortable and/or incorporated that practice into their teaching and some examples of what participants shared on how these practices are being used in the classroom. The specific SMP is noted with an asterisk as a topic covered in OSD professional development.

Table 4

SMP Participants Are Comfortable Using & Incorporating in Their Teaching

Standard of Mathematical Practices	Number of participants incorporating this practice in their teaching	Examples of ways these practices are being used in the classroom
MP.1 Make sense of problems and persevere in solving them.*	7	Math Journals Problem of the Week
MP.2 Reason abstractly and quantitatively.	4	Decomposing numbers (ex. 30 = 3 tens + 0 ones or 2 tens + 10 ones)
MP.3 Construct viable arguments and critique the reasoning of others.*	10	Students sharing answers; asking questions of other students
MP. 4 Model with mathematics.*	9	Connecting problem of the week and math journals with everyday life
MP.5 Use appropriate tools strategically.*	12	Using tools such as protractor, cubes, shapes, measurement, drawings to represent problems.
MP.6 Attend to precision (communication with others using clear definitions in discussion and in their own reasoning).	4	Increase use of vocabulary by teacher and students
MP.7 Look for and make use of structure.	0	
MP.8 Look for and express regularity in repeated reasoning.	0	

*Specific Areas of PD provided by district.

Participants' observations regarding students' mathematical progress in using and learning the CCSSM and SMP

All participants had some positive comments regarding changes they have seen with their students' mathematical ability since implementing the CCSSM and the SMP. As the

teachers shared these events their facial expressions conveyed a feeling of pride for their students and for themselves. A fifth grade teacher shared,

> It's great to watch. To hear them use vocabulary that we haven't used before. They are getting and using the strategies I've never taught before. I find myself using the strategies that I've never taught before too and a lot of time I find myself asking why I haven't ever taught it this way before.

These students had learned the importance of explaining their thinking using mathematics vocabulary and have expanded their conceptual understanding. These ideas and concepts would not have been achievable without the teacher creating an environment that supported and modeled using the vocabulary and strategies. A second grade teacher said, "They are engaged and involved and it's exciting to watch them learn from each other so, that's what I've been enjoying." These students have shown growth with constructing viable arguments. In order to see this growth this teacher had to provide students with a safe environment for discussion and encourage the sharing of ideas. A fourth grade teacher who spoke of her students always wanting to use procedural methods to solve problems shared,

> We just took a test the other day and one of the problems was to solve a multiplication problem any way they wanted and I thought for sure most of the kids would use the standard algorithm, but a lot of the students used the partial product. And some of the kids used place value chart and it was really neat that that's what they were comfortable with and that's what made this problem easy for them to solve.

She expressed how excited she was that even though the students had complained about learning different strategies to solve problems, they had each found a method they were comfortable using. Another teacher talked about her students' increased ability to work on problem solving, "I'm impressed with their problem solving skills and real world problems; that they are able to do instead of just sitting there waiting for someone to solve them. It's amazing." Two teachers mentioned that they have seen benefits in their student using tools to support their mathematical learning. A first grade teacher said, "When using number bonds, I really haven't had anyone seem lost, where with a page of subtraction problems most of the time students don't even know how to start." A second grade teacher talked about a lesson that uses straws to help students understand place value concepts, saying,

> That lesson with all of the straws [grouping straws in bundles], I thought, ok this is the dumbest thing ever. We've used that same lesson now 3 times with counting things. The kids keep reminding me, when we counted all those straws we bundled them into groups of ten. We can do that when we count our laps. We count this…oh, pumpkin seeds; we did a lesson with counting pumpkin seeds and it's like 'ok, are we going to drag all those pumpkin seeds out and start counting one, two, three?' And so, it made so much sense. Now I can see what a great lesson it was for the students to connect to.

While these teachers had positive things to say about the mathematical growth they saw with their students, it is also important to note that the teachers must have created environments that supported their students in this process. It did not always seem clear that the participants understood the growth they had made in this process.

Theme Two: Implementation Expectations/Challenges/Concerns

While teachers had some positive statements regarding the CCSSM, SMP, and the implementation process participants also voiced what they viewed as challenges and concerns regarding the expectations of CCSSM and SMP. The first part of this section will explore the challenges and concerns discussed that are aligned to the classroom and how these affect (a) the teachers and (b) the students. The second part of this section will explore the challenges and concerns as they align to outside influences that hinder or support the implementation process.

Challenges and Concerns Aligned to the Classroom

For the teachers.

As teachers expressed their concerns about using the standards of mathematical practices in their classroom teaching, seven of the participants focused their responses on their lack of knowledge on being able to teach them with fidelity. A third grade teacher said "My concerns lie with how little time I've been using them, so I worry that I wouldn't be effectively teaching it to my students. As more time goes by and I've using them it gets better, but it's still difficult." One of the first grade teachers expressed frustration when she said "My only concern is that I don't know what I'm doing and I mean that it, bottom line. I think I could take those standards and work them in. I really do, but it's just all too much...too much, too new." A comment made by a fourth grade teacher was similarly echoed by a fifth and third grade teacher:

> My concerns are not with the standards but with the transition period. When I came into teaching the old standards were already in place, so that's all I knew. There

> wasn't that transition period. So this is just a whole new ball game for me learning how to transition and how to teach the standards. Yes, I've taught a lot of this stuff before but there are a lot of things that are new. Like protractors. I haven't taught with protractors in my years of teaching. So that is one of my concerns, I'm going to be teaching my kids right along with myself.

When it comes to making shifts in their teaching practices as reported earlier, the majority of participants reported a shift from students working individually toward students working as a community of learners; yet at the same time, they report challenges with giving up the mathematical authority coming from the teacher. A first grade teacher stated, "This is one shift I really need to work on. I'm so used to being the lead teacher. I'm just not sure what that looks like in first grade." One fifth grade teacher admitted that when she is in a hurry to finish teaching math or when she is "squeezing it in" her teaching is very teacher-directed. She said, "While I know it is not always the best way to teach, sometimes there is such a time crunch that I just do it." Another teacher expressed a similar feeling and said,

> I feel like I'm having a hard time doing that [giving up mathematical authority] and I don't know if when the kids come through and they have had this type of math and I've gone through and taught it that I will be able to do that. Part of me too believes teachers are control freaks and by moving away from the text books I'm afraid some things would get lost or won't come across as clearly. But again, I know that is me having issues letting go. (4^{th} grade)

While some comments regarding challenges and concerns of implementing the CCSSM and SMP focused on the lack of ability and knowledge of the teachers to teach these standards,

overwhelmingly the majority of participants had concerns for the challenges they foresaw for students.

For the students.

While the teachers in this study agreed the shifts in teaching and learning mathematics required by the CCSSM and the SMP were necessary and greatly needed for their students to be prepared for the future, they expressed concerns over their students' ability to make the required shifts in their mathematical thinking. When participants focused on what they saw as concerns and challenges during the implementation of the CCSSM and the SMP for their students, the discussion focused on four areas:

(1) Students' ability to learn math concepts when there is such an increased demand on their reading and writing skills imbedded with the math concepts;
(2) Students' ability to explain their thinking to others and in writing;
(3) Students' past experience with rote procedures interfering with their ability (desire) to spend time on conceptual understanding; and
(4) Some of the SMPs are challenging for students to learn such as, critiquing others and attending to precision.

Students' ability to learn math concepts when there is such an increased demand on their reading and writing skills imbedded with the math concepts

Many of the participants shared concerns for students who are learning English as a second language along with students who struggle academically. They feared these students would fall further behind with the increased rigor in mathematics. A fourth grade teacher said,

> In the past, students could just focus on remembering the steps or process of solving a problem. Now, with more word problems and the need to explain how they solved a problem, students have to use skills like reading and writing. Now math is requiring more than just memorizing and that's hard for some students.

A second grade teacher shared, "For students who are struggling with the basic skills, this may all be too much for them." Along with struggling students, a kindergarten teacher said, "I think that the biggest thing is the language. So, especially if we have English learners or even some of our low kids who are language poor, I think learning that language and vocabulary has been difficult for them." A third grade teacher shared her frustrations on the same topic;

> I'm just not sure what they expect us to do. The standards have high expectations for the kids. Kids who may struggle with math have to do multi-steps problems that require so much reading. Those low ones are just going to kind of even fall more behind. They can't even do the math, but then you have to ask them to explain why you are doing this. There is just not enough support for these kids.

Students' ability to explain their thinking to others and in writing

A common theme with the teachers is in this study was that students struggle with the ability to explain their thinking. A third grade teacher said,

> They [the students] are just not used to doing a lot of talking during math. They are used to the teacher telling them what to do and when to do it. It's challenging for them to be told, you tell me how to solve the problem.

A fourth grade teacher said she started using a graphic organizer with her students to support the transition of writing a mathematical explanation. She said, "I told the kids that someone

else needed to solve the problem by following their explanation." When asked how that worked for the students, she responded, "for some better than others. It's just a difficult skill and it's going to take time for them [the students] to see the benefit of doing it." Other teachers addressed concerns about the future for students who were usually not vocal in the classroom and one said, "I'm concerned about losing those kids who are not that vocal and those kids who are not inclined to be discussing, how do you get them to participate?"

Students' past experience with rote procedures interfering with their ability (desire) to spend time on conceptual understanding

Connected to the challenge of students struggling with the ability to explain their thinking participants mentioned students' lack of desire to spend any time working on problems. Many teachers shared that their students were looking for the quickest way to solve problems and the students expressed frustration when asked to go deeper into the solution. A common comment included, students just want to know their answer is correct and move on. A fifth grade teacher shared, "when I ask my students how they solved the problem, their first response is 'I just added or subtracted.' When I ask them probing questions, they look at me like I'm crazy." A fourth grade teacher expressed the following concerns in this same area:

> I love the idea to push these kids to think more deeply, but on the other hand when I'm in the classroom and I'm seeing these kids (and I'm hoping) that as they move up it will be easier, but with this group of kids I'm seeing a lot of anger towards me and the math program requiring them to do more "work." And for those kids who math has come easily with the "drill and kill" the parents are saying my child's self-esteem is being affected because now math is hard. That's telling me that they are

being pushed and they are doing things they haven't been asked to do before. It's not that they can't do it. These are just big shifts for students in fourth grade.

Some of the SMP are challenging for students to learn such as critiquing others and attending to precision.

Some of the participants expressed concern over the difficultly of some of the SMPs for students. A third grade teacher mentioned, "Critiquing others is hard enough for students, but when they are trying to figure out how they found the answer, that is even more challenging" and a fifth grade teacher shared,

> It's challenging because you have those students who get the right answer and don't want to show their understanding. I always tell my students that you don't show your understanding by always getting the right answer. It's difficult for students who their whole life it's been important to just get the right answer.

Along the same lines of communication, a couple of participants reported concerns with students' ability to Attend to precision (MP6). One second grade teacher stated,

> There is so much new vocabulary and add to that this idea of sharing their thinking, it's all so new for students. In the past, students didn't really get to do a lot of sharing of their thoughts, so that is one hurdle. The second hurdle for them is to express these thoughts accurately.

Overall, the participants felt that students were struggling in a variety of ways. Focusing on the concerns for teachers and students Table 5 shows, five teachers' primary concerns were with their ability to teach the SMP; four participants reported having

concerns with the rigor of the SMP for students and 3 participants discussed these concerns for both the teacher and students. Teachers felt the students who had procedural fluency were having difficulty when they were asked how or why they got their answers and students who may have been struggling in the area of reading and writing were now being asked to carry these skills into mathematics. The ability to shift from the mathematical focus on the correct answer to a focus on explanation and understanding was another common concern regarding the SMP for participants.

Table 5

Participants' Concerns with Using the SMP

Teacher's ability to teach the SMP	5
Rigor of the SMP for Students (lack of mathematical skills, reading and writing skills, and second language learners)	4
Teacher's ability to teach the SMP and rigor of the SMP	3

As mentioned earlier in this chapter, teachers discussed how their own lack of knowledge and comfort level with the SMP inhibited their ability to provide better scaffolding for their students. Many felt their lack of experience compounded the students' struggles. A first grade teacher said "I'm learning right along with them and that doesn't always feel good." Most participants were hopeful that as everyone, teachers included, became more proficient with the standards and things would get a little easier.

Theme Two: Challenges and Concerns Aligned to Outside Influences that Hinder or Support the Implementation Process

Not only were participants concerned with the challenges occurring inside their classrooms during the implementation process, but they also voiced concerns regarding

issues outside their classrooms that influenced their ability to use the standards with fidelity. Participants expressed these were issues that affected their daily teaching, but felt that these were all either controlled by the state or at the district level. These concerns focused around four areas:

(1) What does the future of education look like for teachers and students;
(2) Lack of quality mathematical curriculum;
(3) Lack of parental support and concerns regarding the longevity for the common core standards; and
(4) Implementation accountability and quality professional development.

What does the future of education look like for teachers and students?

When participants were asked to address any risk they could see as part of the implementation process, a major issue discussed was, what will the future of education look like for students and teachers? Over half of the teachers mentioned concerns with what the future of education looks like for themselves and students with the continuous use of the Common Core Math Standards and the Standards of Mathematical Practices. Participants felt the uncertainty of the students' education was troubling for them. Many questioned if this was the right path to providing a better education for the students. A fifth grade teacher stated,

> At least with the old standards I knew what my students needed to know to be successful in sixth grade. Now, I'm not so sure. What if they are missing something? I know if we follow the standards the students should be ok, but as a parent of a student going into middle school, how do I know these are the skills needed to be

> successful in higher education math; especially when we don't see any changes at the high school level.

Looking at the concerns of the future from the teachers' perspective, a first grade teacher stated,

> I think the unknown of how are they [students] are going to end up. Is it going to be a direct reflection of me? Are they going to start saying I'm not a good teacher because the students are struggling? I understand in other states they are trying to connect teacher evaluation to student achievement on the Common Core Standards. I can't imagine the stress those teachers are feeling. That just doesn't seem fair.

Lack of Quality Mathematics Curriculum

As mentioned in the introduction of this chapter, OSD, like many others in the state of California, struggled with finding quality math curriculum for teachers to use. While most of the participants supported the curriculum they were using, it had many challenging aspects. First, it was new and offered very different teaching strategies than teachers and students had used in the past. Some teachers had difficulty with these new methods of teaching. A first grade teacher mentioned "I just don't get why we need to do some of these lessons. They seem pointless. Sometimes later in the unit I will see how everything connects, but sometimes I'm still left wondering." The second issue, addressed by the participants in regards to the curriculum, had to do with the lack of scaffolding offered for second language learners or students who may be struggling. According to the teachers, the support needed for these students was limited or nonexistent with the curriculum they were using. This then required them to modify existing lessons or create something new. This

lack of support had an added disadvantage because parents were having difficulty helping students with their homework. A fifth grade teacher said,

> It's difficult when most of the parents of my students were only taught how to solve problems using one procedural method. They struggle helping their child with homework because they lack a conceptual understanding of the content. Then they get angry because we are trying to teach different strategies. They feel if they got though life using one method to solve a problem, then it should be fine for their child too. It's difficult to explain how important it is for the students to build a conceptual understanding of mathematics and that the procedural methods will be taught when the students have a true understanding of the concepts.

Lack of Parental Support and Longevity for the Common Core Standards

According to the participants in this study dealing with parents concerns did not stop with the math curriculum. Like many states this community had a parent movement that spoke out against the Common Core (CC) standards in general and were calling for the removal of these standards. Despite the fact that the Governor of California assured that CC standards were here to stay, many teachers felt caught in the middle of this political debate. A third grade teacher expressed her concerns by saying, "I'm putting in countless hours trying to learn all this new stuff and it could all change next year. On the days I'm tired, I ask myself, why? What's going to stop someone from changing their mind about this?" The feeling of uncertainty regarding the longevity of the CC standards was echoed throughout the interview process. A participant who has been teaching the longest said, "I have seen many things come and go in my career and although I really like the Common Core

Standards, I don't trust they will be around for long." This uncertainty added an extra burden on the teachers as they struggled to learn and teach the new standards and practices. Teachers were concerned that community pressure will win the battle of the Common Core Standards and as in other states, California will pull these standards and move on to something else.

Implementation Accountability & Professional Development

Another issue teachers addressed was who was making sure everyone was implementing the new standards. One teacher said, "I know of a teacher who is using the old math curriculum and I'm wondering why? Isn't someone making sure we are all doing the same thing? Where is the accountability?" Teachers felt if all teachers were not using the CC math standards or the SMP it would put students at a disadvantage with the next grade level placement. A third grade teacher said:

> If a second grade teacher is not teaching the CC standards this year, then next year, I may have some of those students in my class. That means not only are those students not ready for the next grade level math, but it's going to be twice as much work for me. I'm going to have to get them caught up, as well as, teach them what they need to know for third grade."

At Orchard School District, the curriculum department allowed each site administrator to oversee the implementation process of the Common Core Standards and some participants felt that not all administrators were holding teachers accountable for implementing the new standards and wondering why not. A fourth grade teacher

commented, “it doesn’t seem fair that I’m working so hard to make this new material work and someone else is just pulling from last year’s material. That needs to change.”

Along the concerns of implementation accountability, but adding the topic of professional development a first grade teacher said:

> My concerns might be that I don’t feel like all teachers are prepared enough for sure. Some are more prepared than others. Some are more willing than others. That’s a concern because I think there needs to be as much consistence as possible throughout. Obviously because it’s new we are not there yet, but someone should be thinking about this. The district needs to be thinking about how to support teachers who are comfortable with teaching and using the standards, but are ready to go a little deeper into the process. At the same time, how are they going to address the needs of teachers who are doing very little in this implementation process and need extra support?

Not only were participants concerned about every teacher using the Common Core Math Standards and the Standards of Mathematical Practices in their teaching, but they also voiced concern about the extra support some teachers may need during this process.

In the interview participants were specifically asked to address if they felt that any PD they had attended supported them with implementing the CCSSM and the SMP. Only one participant felt that the PD offered had not provided support in the implementation of the new standards. This participant mentioned she remembers sitting in a room with the topic of CC being discussed, but said, “Honestly my mind was on other things. I really wasn’t paying attention. So when we got the new math material I went, so this is what it’s

all about." All of the other participants reported that the PD they attended provided much needed background, but admitted they were looking for more. Participants' responses indicated that the value of the PD depended on where they were at in the learning process of the Common Core Math Standards or the Standards of Mathematical Practices. One participant felt that a topic was not covered and another loved the in-depth coverage of this topic. For example, one participant said, "I just wish for some of these PD we would have been allowed to really get into the standards. It just seemed some of these were a waste of time." While another participant stated:

> Unpacking the standards was very helpful. I loved having the time to get into them. I thought it was great learning which standards are considered major standards and which ones are considered supporting standards. Now that we have curriculum and we are using them in the classroom, I understand what each one means and I'm more effectively able to teach it.

It was clear opinions of the participants differed on which PD they found important and meaningful for themselves. A first grade teacher responded:

> I do feel like I have been supported with PD opportunities because I feel like I have received ideas that I might not have ever thought of. I've been given other resources. I have been able to see other people teach and see what it looks like. PD has helped me find resources that I'm comfortable with.

A kindergarten teacher mentioned, "I think the district has offered us workshops and other ongoing opportunities, which is nice. Some of them have been really focused on things I can do and use." A second grade teacher expressed that she was grateful for the math parent

nights the district held, she said, “these really helped my parents, and that helped me. They [parents] backed off a little bit which gave me one less thing to deal with.”

As participants discussed future desires for PD most of them spoke about the need to “see other teachers in action.” A second grade teacher said “I just want to make sure I’m doing what it should look like.” Another teacher said “getting my kids in groups and having them talk is one thing, but I want our conversations to go much deeper and I’m not sure what that looks like. It would be nice to see someone leading a math conversation.” Although the desire to see other teachers was high on the list for these participants in future PD, another common comment was the need for more PD that focused on their individual needs. One teacher said:

> I feel pretty good about what I’m doing, but I know I still have a lot to learn. So I don’t want to go into a PD that is covering basic skills for the SMP. I want something that’s going to help me take my students to the next level.

CHAPTER FIVE –DISCUSSION & RECOMMENDATIONS

Discussion

The purpose of this study was to explore teachers' perceptions of the Common Core Standards for Mathematics, how teachers were implementing shifts in their teaching of the SMP, and the role professional development played in this process. According to the California's Math Framework, (2015) "California's implementation of the California Common Core State Standards for Mathematics demonstrates a commitment to providing a world-class education for all students, narrowing the achievement gap, supporting lifelong learning, and helping students develop the skills and knowledge necessary to fully participate in the global economy of the twenty-first century" (p.2). The successful implementation of the CCCSM and SMP is a difficult and challenging process for everyone involved, but peculiarly for classroom teachers. This process can be compounded for teachers by the different levels of acceptance of the Common Core Standards; how comfortable and knowledgeable they are teaching these standards; and how much support they are receiving through professional development. As districts across the United States search for ways to support teachers in the implementation process of the Common Core Math Standards and the Standards of Mathematical Practices it is important for researchers to explore teachers' experiences during the use of these standards.

The themes and findings discussed in this project represent a glimpse at one point into the implementation process of the Common Core Standards and the Standards of Mathematical Practices at a small Ventura County School District. This study did not consider how a participant's views may have changed as the school year progressed as everyone became more comfortable with the teaching of the new standards. Although these

participants had some common views and experiences it may not be a reflection of teachers in other locations. While purposeful sampling was used to provide a diverse sample of participants, these participants were all volunteers. The teachers most likely to participate in this type of study may also have an open mind to change and to discuss the successes and challenges of this process. All of the participants knew the researcher, which may have provided a level of trust in the interview process that allowed all participants to openly share their concerns, challenges, and successes freely. It may also have prohibited some participants from expressing their ideas and opinion to someone who they knew and would see again.

This discussion will analyze the findings of this study based on the two main themes and the subcategories within each theme discussed in Chapter 4. Theme One considered Positive Implementation Perspectives and was divided into three sub-categories: (1) Participants' perspective regarding the CCSSM and SMP; (2) Participants' Perception of Positive Changes in Their Teaching Practices; and (3) Participants' observations regarding students' mathematical progress in using and learning the CCSSM and SMP. Theme Two considered the Implementation Expectation, Challenges, and Concerns and was divided into two sub-categories: (1) Challenges and Concerns Aligned to the Classroom with the focus on how these may affect the teachers as well as the students; and (2) Outside Influences that Hinder or Support the Implementation Process. This discussion will also consider the role professional development played during the implementation process for these participants.

Theme One - Positive Implementation Perspectives

Overwhelmingly these participants had strong positive feelings regarding the changes the Common Core Math Standards and the Standards of Mathematical practices bring to the education process. These teachers not only saw positive changes in their teaching practices, but in a short time they were able to see mathematical growth in their students too. These findings revealed that the most common shift in teaching practices by participants revolved around three of the seven Bay-Williams, et al. (2014) *Shifts in Teaching Practices*. These seven shifts are believed to be necessary for teachers in order to make a connection with the Common Core Math Content Standards and the SMP in their teaching. Participants shared that changes in their teaching practice included:

1. A shift from mathematical authority coming from the teacher or textbook toward mathematical authority coming from sound student reasoning;
2. A shift from focus on correct answer toward focus on explanation and understanding; and
3. A shift from students working individually toward community of learners.

These three shifts in teaching practice support SMP3-Construct viable arguments and critique the reasoning of others. The Common Core Standards and the SMP not only require students to think more about how to solve math problems, but these standards also require students to be able to share their thinking process. According to Kilpatrick, et al. (2001) in order to promote mathematical proficiency there must be a capacity to think logically about the relationship among concepts and situations and have the ability to explain and justify your reasoning. A frequent comment from these participants included how they support the

"thinking" that these standards required of students and how beneficial they feel this is to build students' understanding of mathematics. Participants agreed that an important component of students' mathematical thinking is their ability to share their thoughts with their teacher and their peers. These teachers recognized that using students' conversation provided students with opportunities to explore math in a meaningful way and allow them to see strategies they might not have thought about using. Jacobs et al. (2010) reports that noticing the complexity and details of the different strategies students use can provide insight into the students understanding of the concept and support a teacher in deciding how to respond. These teachers discovered through the increased use of student mathematical conversations in the classroom, students used new vocabulary, had an increase in their ability to listen and respond to what to their peers were saying and undertook a variety of strategies to solve problems. Classroom conversations allowed teachers to see how using different strategies to solve the same problem supported students' deeper understanding of concepts. Some teachers were surprised when some students did not fall back on procedural skills, but used new strategies to solve complex problems. The idea of students starting with a conceptual understanding in mathematics, which can lead to a procedural understanding, is an important component of the Common Core Math Standards. This deeper understanding allows students to find a solution to a problem when a procedural method may be forgotten (Rittle-Johnson & Alibali, 1999). Kilpatrick, et.al (2001) contend that learning with understanding strengthens students' abilities to organize material, encourages fluency, supports learning with other related concepts, and increases retention of thoughts ideas and skills. While participants had positive things to say regarding how they were implementing the Common Core Math Standards and the Standards of Mathematical Practices in their

classroom teaching, they still had unanswered questions and concerns. These concerns seemed to overwhelm participants during this implementation process.

Theme Two: Implementation Expectations/Challenges/Concerns

One of the most common concerns expressed during the interviews revolved around the teachers' insecurity of correctly teaching the Common Core Math Content Standards and the Standards of Mathematical Practices. Guskey (2010) mentions, when teachers are unsure they can make new practices or procedures work, they are afraid to risk failure and implement them. The unknown aspects of implementing something new caused a great deal of stress for these participants. Teachers were not sure when to intervene in students' mathematical conversations and were uncertain of what types of questions to ask in order to ensure all students were involved in the conversation. Peressini et al., (2004) believe in order for meaningful mathematical discourse to occur in the classroom a teacher must be skillful in posing questions, listen carefully to students' ideas, be able to model more sophisticated ideas through the rephrasing of student thoughts, and decide when to provide more information. These are skills the participants seemed to struggle with during this process. These participants also struggled with not always understanding the objective of a math lesson or being able to see the long term goal of the learning process for their students. There were times the participants wondered why they were being asked to introduce a particular strategy or method, and they questioned if they would get positive results from their students when using these new strategies. All of this uncertainty left these participants second guessing their own mathematical knowledge and ability to teach math. At the height of their stress level a couple of participants commented about wanting to go back to teaching

math the way they had previously taught and teach the procedural methods they had learned as students. Research has found that as teachers are exposed to new and what can seem awkward skills, the level of frustration can build and they rely on the procedural process they are familiar with in teaching math (Fullan, 2001; Guskey, 2010; Joyce & Showers, 1982). Without a strong understanding of the standards or the math curriculum, teachers also felt an inability to differentiate their instruction to meet the needs of all of their students. Teachers mentioned the Common Core aligned curriculum they were using did not provide teaching strategies to reach students who may have been struggling with the concepts and they felt they did not have enough knowledge or experience to pull from to provide added support for these students.

While teachers had concerns regarding their own ability to teacher the Common Core Standards and the Standard of Mathematical Practices, a big part of their challenges and concerns focused on the students. Participants voiced concerns for students who may struggle academically in the area of math and/or for students who were learning English as a second language. These teachers worried the increased demand for reading and writing in math, would make it difficult for some students to be successful in learning these new content standards and the SMP. The teachers in this study felt the Common Core Math content standards and the SMP do not support struggling students, and wondered if these students would fall further behind their peers in the area of mathematics with these new requirements. Although the participants saw some mathematical advantages when students verbally shared their thinking, they felt the higher demand for written expression of these thoughts weighed heavily on some students. *Principles for Mathematics Instruction for ELLs* (Moschkovich, 2013) state "mathematical instruction for English Language Learners

should align with the CCSS" (p.11) in four ways: balance conceptual understanding and procedural fluency; maintain high cognitive demand; develop productive beliefs about mathematics; and engage students in the mathematical practices. These participants were still uncertain of the benefits with having a stronger conceptual level of mathematics. They struggled with the idea that all students could benefit from opportunities to solve problems, model, and communicate their thinking. Participants also had difficulty with students who struggled with the shift from mostly procedural teaching and learning to the more in-depth process of conceptual understanding of mathematics. Many teachers commented on students expressing frustration regarding the extra time and commitment it took to solve problems. According to the teachers, students were looking for quick solutions rather than an understanding in the process. Some participants felt this issue was compounded by parental concerns regarding this major shift in mathematics.

When considering challenges and concerns aligned to outside influences that hindered the implementation process, parental opinion of the Common Core Math Standards was one of the top topics of conversation. While some parents supported these new standards, there was a large group of parents in the Orchard School District that openly expressed their concern with the use of these standards. These parental objections added another layer of stress for these teachers and left them feeling caught in the middle of a heavily political debate. The district tried to address the parental concerns by offering parent nights at the school sites that focused on new mathematical tools and strategies for Common Core Math Standards. Although this parent support alleviated some parental pressure, participants were still addressing weekly emails from parents regarding the math curriculum and their frustration of trying to understand the material. The math curriculum these

participants were using was aligned to the Common Core Standards and the SMP, but the participants felt it lacked adequate support for parents to help their students at home. Watching other states dealing with community pressure and move away from the Common Core Standards played into the insecurity of the longevity of these new standards. The uncertainty of how long the standards will be around provided a mental hurdle for these participants. They knew this implementation was requiring more time and dedication from their personal lives and understood that this was all part of the process of implementing so many new things; but unfortunately they also had to deal with the idea that the State could make a decision for these standards to go away. The lack of faith these teachers had in the State Education system's continual use of the Common Core Standards created fear that if these standards were to go away, the teachers would be back to learning something new all over again.

What role did PD play in the Implementation Process?

The participants' opinions of the role previous PD played during the implementation process differed. While most participants had positive statements regarding the PD they received from the district, none of the participants reported a direct connection between their use of these SMP and a PD session. All but one participant agreed the PD they attended provided at least some background knowledge of the Common Core Standards and the Standards of Mathematical Practices. Data showed some participants remembered information from one PD more than another. There was a comment from one teacher about wishing more time had been spent on unpacking the standards, while another teacher loved the PD where standards were unpacked. There were no comments from the participants

regarding how a particular PD supported them with the use of these SMP; nor did the participants comment on a particular skill or strategy that they learned during the PD and were using in their teaching. Most comments revolved around, yes, the PD we attended last year was helpful. Even when probed with an additional question of how did the PD help you, responses were vague and some comments included, “they helped me know what was coming down the road with math.” While another participant said “I feel like I have received ideas that I might not have ever thought of,” but they were unable to provide specific ideas. Despite participants’ inability to directly connect the shifts they made in their teaching to the PD sessions, all participants reported a higher usage of the four SMP in their teaching that were addressed during the series of PD provided by their district; (1) MP. 1: Make sense of problems and persevere in solving them; (2) MP.3: Construct viable arguments and critiques the reasoning of others; (3) MP.4: Model with mathematics; and (4) MP.5: Use appropriate tools strategically. These findings revealed that these teachers used, were comfortable using, and found student success in the four SMPs in which they attended professional development. Participant comments included reference to using more problems solving strategies, providing students the opportunity to share the strategies they used to solve mathematical problems and providing opportunities for students to see or use models during math. It is possible that this lack of connection to specific ideas could stem from the length of time that had passed between the PD sessions and the use of these SMP in the classroom. The PD for this district was completed one year before the implementation of the CCCS for California as well as one year before the data collection. As discussion continued with these participants, it seemed that these teachers were more focused on the skills they felt they currently lacked with the SMP, rather than the knowledge they learned regarding the SMP in

previous PD. Participants were concern with their lack of knowledge of how to get all students talking during math and how to support student who may struggle. None of the participants reported using the other four SMP that were not addressed in any professional development sessions; MP.2 Reason abstractly and quantitatively; MP.6 Attend to precision; MP.7 Look for and make use of structure; and MP.8 Look for and express regularity in repeated reasoning. Some participants mentioned that they were unsure of the meaning and expectation of these practices. Even though participants were unable to connect the shifts they made in their teaching practices to the PD sessions they attended, the data collected from this study shows these participants made shifts in their teaching practices that aligned with the SMP covered in the PD sessions.

When these participants were asked what support future PD can offer, the responses focused on two areas. First, they expressed an interest to see other teachers using the SMP in a classroom setting. Some participants spoke about being able to see what this "new way" of teaching looked like in the classroom. They wanted to compare what they were doing in their classroom to another teacher who had experience teaching with these new standards. These teachers were looking for assurances that they were implementing these standards and practices correctly and at the same time looking for new strategies to use. Second, they indicated an interest in PD providing a diversified approach of supporting teachers in the implementation process. Participants mentioned that PD should provide teachers with a level of support which focuses on their individual level of understanding of the content standards and the SMP. One teacher mentioned, "If I'm comfortable using a strategy in my classroom, then I don't want to sit in a mandatory PD where that is the focus." At the same time these teachers were aware that there were some teachers on their school sites who were not

implementing the required shifts of these new standards and practices and they would need support with some basic understanding of this process. According to Guskey (2010), teachers implement change at different rates and fidelity and an important principal of PD is to provide teachers support and collaboration opportunities.

Collectively the results show teachers were responding to the demand and expectations of the Common Core Math Standards and the Standards of Mathematical Practices. This study revealed that participants expressed many positive changes happening with the implementation of these standards and practices. They were in agreement of the important role these new standards play in preparing students for the future. According to these teachers, critical shifts were happening in the way mathematics was being taught in the classroom and students were responding to these new ideas. These teachers expressed excitement with the mathematical growth they had seen with their students in such a short time. Some teachers shared how they were building their own conceptual understanding as they taught more in-depth content. One teacher shared "As I was teaching a lesson on fractions it dawned on me that's why we teach this particular procedure. I have just been teaching the procedure and encouraging the student to memorize the steps so much that I forgot the why behind it." While these finding can be powerful in the data released regarding the CCSSM and the SMP there are still many areas of improvement to focus on. These include lack of additional support for struggling students, outreach for parents to provide a deeper of understanding of these important changes occurring in the education system, and professional development that meets the diverse needs of the teachers.

Recommendations

As a researcher and educational supporter of pre-service and in-service teachers, this study has shown me firsthand the challenges and struggles teachers are facing as they navigate through the process of teaching with new standards while making shifts in their teaching practices. This study exposed the challenges and struggles teachers are dealing with inside the classroom with their teaching and their students' ability to adjust to these changes in teaching and thinking. These participants shared how issues outside the classroom, such as lack of community support and uncertainty of the state's commitment to the Common Core Standards, affected the level of stress and frustration during this process. To combat these feelings teachers need to know that the State of California is committed to the Common Core Standards and will continue to offer districts support in implementing them. The State Education Department and school districts need to continue to find ways to support parents that allows them to see the value of this educational shift during this transition time. Universities can provide added support by collaborating with local school districts to assist with parent or family math nights, where parents and students can see the benefit of having a deeper mathematically understanding.

These findings also revealed the dedication and belief these particular teachers have in how the use of the Common Core Math Standards and the Standards of Mathematical Practices can provide a deeper understanding of mathematics for students. Despite the extra hours these teachers spend on preparing math lessons, the added stress of parents and community members, and the concerns these new standards and practices demanded of their students; these teachers were committed to making this process work in their classrooms. In a short period of time teachers were able to see some mathematical growth in their students

strategies used to solve problems. Additionally, students think more about the math problems and have the ability to share their thought process with other students. At the same time, this study revealed the apparent concern these teachers had regarding the increased rigor that comes from these new standards for students who may already struggle in the area of mathematics. These teachers were looking for ways to support these students and they were unable to find it in the math curriculum they were using. The lack of experience and knowledge with the content standards and SMP made it difficult for these teachers to know where to make adjustments in their lessons. While many districts have offered extra support for students who may need help with reading skills, most have looked the other way when it comes to extra support for math. The belief has been that math skills simply require students to memorize facts and procedures. The Common Core Standards now require a crossover of reading and writing skills in mathematics. Districts will need to consider ways to support teachers with struggling students by offering intervention opportunities that incorporate reading, writing, and mathematics. This change can support students in developing the Common Core Standards and Standards of Mathematical Practices. There is not only an increased rigor for students with Common Core Standards, but teachers need to be able to have a mathematical understanding that allows them to see if a student's thinking is taking them down a wrong path. Lessons can quickly become failures if teachers cannot ask meaningful questions while students are explaining their thinking. One consideration is that an elementary credential be limited to a grade span such as Kindergarten-Second or Third-Fifth. This would allow pre-service teachers to focus their math skills within that grade level span and provide a more content-knowledgeable teacher for students. While these finding have given much needed information on teachers'

perspectives and the successes and challenges teachers are dealing with during the implementations of the Common Core Standards and Standards of Mathematical Practices, the next area will focus on the next steps for professional development.

Participants voiced concerns over the future of professional development. They wanted it to be diversified enough to meet their immediate and future needs, and they were no longer interested in a "one size fits" all option. These participants recognized that teachers learn at a different pace and some welcome change, while others are slow to make necessary changes. Some teachers would appreciate the opportunity to view teachers teaching a common core lesson. This process can be supported by districts providing release time for teachers to complete an observation of another teacher and the opportunity to discuss what they saw during the lesson. For many teachers, this will be a cultural shift observing and being observed by colleagues. It will take an environment that offers opportunities to learn, and not be judged. School Districts will need to work on providing such an environment. This practice of observation and being observed is used frequently in a University Teacher Education Program. With continual use of these observations, pre-service teachers will leave teacher preparation comfortable with this process. Universities can consider how they can become more involved to support districts and in-service teachers with this practice.

Overall these participants wanted professional development that meets them at their level of experience and expertise of this implementation process. One teacher said, "just please make sure there is more professional development. Don't leave us alone after one year. There is so much more I need to learn." This study supports the importance of a professional development survey. Providing teachers the opportunity to determine their

professional development needs is critical in the success of expanding teachers' skills and knowledge. When teachers have some input to what they are learning it becomes more meaningful and useful in their teaching practices. In order to achieve this type of PD, districts can send teachers a survey providing a list of topics and an "other" category to which teachers can provide qualitative data. For example, teachers may express a need to take a deeper look into the other SMP that were not addressed by the PD sessions, such as MP. 7 Look for and make use of structure or MP. 8 Look for and express regularity in repeated reasoning. Some teachers may want to learn more about facilitating a mathematical conversation in their classroom or they may want to learn more about teaching particular mathematical content. A district can determine which topics have the greatest request and plan PD opportunities in a choice model where teachers move to a session based on the topic. While this type of PD model can require a lot more planning, expenses and challenges, the rewards may be worth it. Research is lacking in this model of professional development. Current and future research needs to consider how to support districts in this type of professional development as well as determine any short or long term benefits from this process.

The outcome of this study also reveals that despite the growth the teachers have seen in themselves and in their students, there are still many challenges to overcome. There is a need of assurance that unlike other states the Common Core standards will remain intact in California. This assurance will provide teachers with a level of confidence in knowing that all of the extra time and effort they are putting into their lessons, will be useful for them and their students for some time. There is also a need to address how to best support students who are learning English as a second language along with students who may be struggling

with the high demand of the verbal and written expectation that the CCSSM and SMP bring to the classroom. Lastly, there is a need to differentiate the professional development offered to teachers to meet their diverse needs in the implementation of these standards. While some of these teachers showed a beginning level of making shifts in their teaching, they also expressed areas where they want and need support. This study reveals future research is needed to support districts in providing diversified professional development opportunities for teachers. Consideration should also be given at the University level in how to provide more in-service learning opportunities to not only build teachers mathematical content knowledge but the pedagogy of teaching mathematics with the Standards of Mathematical Practices.

Reference

Association for Supervision and Curriculum Development. (2012). *Fulfilling the promise of Common Core State Standards: Moving from adoption to implementation to sustainability.* Retrieved April, 2013 from http://educore.ascd.org/resource/Download/1d60f46d-b786-41d1-b059-95a7c4eda420

Banilower, E., Boyd. S., Pasley, J., & Weiss, I. (2006). *Lessons from a decade of Mathematics and Science reform*. Chapel Hill, NC: Horizon Research.

Bair, S., & Rich, B. (2011). Characterizing the development of specialized mathematical content knowledge for teaching in algebraic reasoning and number theory. *Mathematical Thinking and Learning, 13*(4), 292-321.

Ball, D. (1990). The mathematical understanding that prospective teachers bring to teacher education. *The Elementary School Journal*, 90(4) 449-466.

Ball, D. (2011). *Learning to teach the common core*. MSPnet Academy-Webinars

Ball, D., Thames, M., & Phelps, G. (2005). *Articulating domains of mathematical knowledge for teaching.* Paper presented at the annual meeting of the American Educational Research Association, Montreal, Quebec, Canada.

Ball, D., Thames, M., and Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education, 59*(5), 389-407.

Battista, M., Fey, J., King, K., Larson, M., Reed, J., Smith, M., Strutchens, M., & Sutton, J., (2007). Connecting research and practice at NCTM. *Journal for Research in Mathematics Education, 38* (2), 108-114.

Bay-Williams, J., McGatha, M., Kobett, B., & Wray, J. (2014). *Mathematics coaching: Resources and tools for coaches and leaders, K-12*. Boston, MA: Pearson Education, Inc.

Boaler, J. (1998). Open and closed mathematics: Student experiences and understandings. *Journal for Research in Mathematics Education, 29* (1), 41-62.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33* (8), 3-15.

Bullough, Jr. R. (2001). Pedagogical content knowledge circa 1907 and 1987: A study in the history of an idea. *Teaching and Teacher Education, 17*, 655-666.

Burkhardt, H., & Schoenfeld, A. (2003). Improving educational research: Toward a more useful, more influential, and better-funded enterprise. *Educational Research, 32* (9) 3-14.

Byrnes, J. (1992). The conceptual basis of procedural learning. *Cognitive Development, 7,* 235-257.

Cai, J. (2003). What research tells us about teaching mathematics through problem solving. In F. Lester (Ed.) *Research and issues in teaching mathematics through problem solving* (pp. 241-254). Reston, VA: National Council of Teachers of Mathematics.

California Department of Education. (2012). *Common Core State Content Standards for Mathematics*. Retrieved from http://www.cde.ca.gov/be/st/ss/documents/ccssmathstandardaug2013.pdf

Carpenter, T. P., Fennema, E., & Franke, M.L. (1996). Cognitively guided instruction: A knowledge base for reform in primary mathematics instruction. *Elementary School Journal, 97* (1), 3-20.

Chapin, S. & Johnson, A. (2006). *Math Matters: Understanding the math you teach.* Sausalito, CA: Math Solutions.

Chapin, S., O'Connor, C., & Anderson, N. (2009). *Classroom Discussions: Using math talk to help students learn.* Sausalito, CA: Math Solutions.

Clarke, B. (2008). A framework of growth points as a powerful teacher development tool, In D. Tirosh & T. Wood (Eds.), *International handbook of mathematics teacher education:* Vol. 2. *Tools and processes in mathematics teacher education* (pp.235-256). Rotterdam, The Netherlands: Sense Publishers.

Cobb, P., Wood, T., Yackel, E., Nicholls, J., Wheatley, G., Trigatti, B., & Perlwitz, M. (1991). Assessment of a problem centered second-grade mathematics project. *Journal for Research in Mathematics Education, 22* (1), 3-29.

Cochran, K., DeRuiter, J. & King, R. (1993). Pedagogical content knowing: An integrative model for teacher preparation. *Journal of Teacher Education, 44* (4), 263-272.

Duffy, G., & L. Roehler. (1986). Constraints on teacher change. *Journal of Teacher Education, 37,* 55–58.

Eisenhart, M., Borko, H., Underhill, R., Brown, C., Jones, D., & Agard, P. (1993). Conceptual knowledge falls through the cracks: Complexities of learning to teach mathematics for understanding. *Journal for Research in Mathematics Education, 24* (1), 8-40.

Fennema, E., Carpenter, T., Franke, M., Levi, L., Jacobs, V., & Empson, S. (1996). A longitudinal study of learning to use children's thinking in mathematics instruction. *Journal for Research in Mathematics Education, 27* (4), 403-434.

Fraivilling, J. (2001). Strategies for advancing children's mathematical thinking. *Teaching Children Mathematics, 7*(8), 454-459.

Franke, M., Carpenter, T., Levi, L., & Fennema, E. (2001). Capturing teachers' generative change: A follow-up study of professional development in mathematics. *American Educational Research Journal*, 38(3), 653-689.

Franke, M., Webb, N., Chan, A., Ing, M., Freund, D., & Battey, D. (2009). Teacher questioning to elicit students' mathematical thinking in elementary school classrooms. *Journal of Teacher Education, 60*, 380-390.

Fullan, M. (2001). *Leading in a culture of change.* San Francisco, CA: Jossey-Bass.

Fullan, M., & Stiegelbauer, S. (1991). *The new meaning of educational change.* 2nd ed. New York, NY: Teachers College Press.

Gess-Newsom, J. (1999). Introduction and orientation to examining pedagogical content knowledge. In J. Gess-Newsom & N. G. Lederman (Eds.), *Examining pedagogical content knowledge* (pp.3-20). Elmsford, NY: Pergamon Press, Inc.

Grossman, P., & Schoenfeld, A. (2005). Teaching subject matter. In L.Darling-Hammond, J. Bransford, P. LePage, K. Hammerness, & H. Duffy (Eds.), *Preparing Teachers for a Changing World,* (pp. 201-231). San Francisco, CA: Jossey-Bass.

Guskey, T. (1986). Staff development and the process of teacher change. *Educational Researcher, 15* (5), 5-12.

Guskey, T. (2010). Professional development and teacher change. *Teachers and Teaching: Theory and practice,8* (3) 381- 391.

Hallett, D., Nunes, T., & Bryant, P. (2010). Individual differences in conceptual and procedural knowledge when learning fractions. *Journal of Educational Psychology, 102* (2), 395-406.

Hiebert, J. (2003). Signposts for teaching mathematics through problem solving. In F. Lester (Ed.) *Research and issues in teaching mathematics through problem solving* (pp.53-61) Reston, VA: National Council of Teachers of Mathematics.

Hiebert, J., Carpenter, T., Fennema, E., Fuson, K., Wearne, D., Murray, H., Olivier, A., & Human, P. (1997). *Making sense: Teaching and learning mathematics with understanding.* Portsmouth, NH: Heinemann.

Hiebert, J., Gallimore, R., & Stigler, J. (2002). A knowledge base for the teaching profession: What would it look like and how can we get one? *Educational Researcher, 31* (3), 3-15.

Hiebert, J., & Lefevre, P. (1986). Conceptual and procedural knowledge in mathematics: An introductory analysis. In J. Hiebert (Ed.), *Conceptual and procedural knowledge: The case of mathematics* (pp.1-27). Hillsdale, NJ: Erlbaum.

Hill, H. (2010). The nature and predictors of elementary teachers' mathematical knowledge for teaching. *Journal for Research in Mathematics Education 41* (5), 23-44.

Hill, H., Ball, D., & Schilling, S. (2008). Unpacking pedagogical content knowledge: conceptualizing and measuring teachers' topic-specific knowledge of students. *Journal for Research in Mathematics Education, 39* (4), 372-400.

Jacobs, V., Franke, M., Carpenter, T., Levi, L. & Battey, D. (2007). Professional development focused on children's algebraic reasoning in elementary school. *Journal for Research in Mathematics Education*, *38*(3), 258-288.

Jacobs, V., Lamb, L., & Philip, R. (2010). Professional noticing of children's mathematical thinking. *Journal for Research in Mathematics Education, 41* (2),169-202.

Jenkins, S., & Agamba, J. (2013). The missing link in the CCSS initiative: Professional development for implementation. *Academy of Educational Leadership Journal*, *17*(2), 69-79.

Joyce, B., & Showers, B. (2002). *Student achievement through staff development.* Alexandria, VA: Association for Supervision and Curriculum Development.

Kieren, T.E. (1993). Rational and fractional numbers: From quotient fields to recursive understanding. In T.P. Carpenter, E. Fennema, & T.A. Romberg (Eds.), *Rational numbers: An integration of research* (pp.49-84). Hillsdale, NJ: Erlbaum.

Kilpatrick, J. (2000). Reflections on verifying change in school mathematics. *Journal of Classroom Interaction, 35,* (1), 28–30.

Kilpatrick, J., Swafford, J. & Findell, B. (2001). *Adding It Up: Helping children learn mathematics.* Washington, DC: National Research Council.

Lambdin, D. (2003). Benefits of teaching through problem solving. In F. Lester (Ed.) *Research and issues in teaching mathematics through problem solving,* (pp. 3-15). Reston, VA: National Council of Teachers of Mathematics.

Le Fevre, D. (2013). Barriers to implementing pedagogical change: The role of teachers' perceptions of risk. *Teaching and Teacher Education 38,* 56-64.

Ma, L. (1999). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States.* Mahwah, NJ: Lawrence Erlbaum.

McCallum, B. (2011). Structuring the mathematical practices. Retrieved from http://commoncoretools.me/2011/03/10/structuring-the-mathematical-practices/

Moschkovich, J.N. (2012). Mathematics, the Common Core, and Language: Recommendations for mathematics instruction for ELs aligned with the Common Core. *Proceedings of the Understanding Language Conference, 2012.* Stanford University, CA. Retrieved from http://ellstanford.edu/publication/mathematics-common-core-and-language

National Academy of Education (NAED). (2009). *Teacher Quality*. Washington, DC. NAED.

National Council of Teachers of Mathematics. (2007). Connecting research and practice at NCTM. *Journal for Research in Mathematics Education 38* (2) 108-114.

National Council of Teachers of Mathematics (1991). *Professional Standards for Teaching Mathematics.* Reston, VA: NCTM.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: NCTM.

National Council of Teachers of Mathematics. (2010). Why is teaching with problem solving important to student learning? *Research Brief*. Reston, VA: NCTM.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Trends in State Implementation of the Common Core State Standards.* Washington, DC: Educator Effectiveness.

National Mathematics Advisory Panel. (2008). *Foundations for Success: The Final Report of the National Mathematics Advisory Panel.* Washington, DC: U.S. Department of Education.

National Staff Development Council (NSDC) & The School Redesign Network (2009). *A Status Report on Teacher Development in the United States and Abroad.* Palo Alto, CA: Stanford University. National Staff Development Council and the School Redesign Network.

North Carolina State University (2011). *Supporting Implementation of the Common Core State Standards for Mathematics.* Raleigh, NC: The William & Ida Institute for Educational Innovation.

Park, S. & Oliver, S. (2008). Revisiting the conceptualisation of pedagogical content knowledge (PCK): PCK as a conceptual tool to understand teachers as professionals. *Research Science Education, 38,* 261-284.

Peressini, D., Borko, H., Romagnano, L., Knuth, E., & Willis, C. (2004). A conceptual framework for learning to teach secondary mathematics: A situative perspective. *Educational Studies in Mathematics, 56* (1), 67-96.

Provasnik, S., Kastberg, D., Ferraro, D., Lemanski, N., Roey, S., & Jenkins, F. (2012). *Highlights from TIMSS 2011: Mathematics and Science Achievement of U.S. Fourth- and Eighth-Grade Students in an International Context* (NCES 2013-009 Revised). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

RAND Mathematics Study Panel. (2003). *Mathematical Proficiency for all students: Toward a strategic research and development program in mathematics education.* Santa Monica, CA: RAND.

Rentner, D. (2013). *An overview of States' progress and challenges.* Washington, DC. Center on Education Policy.

Rittle-Johnson, B., & Alibali, M. (1999). Conceptual and procedural knowledge of mathematics: Does one lead to the other? *Journal of Educational Psychology, 9* (1), 175-189.

Russell, S. (2012). CCSSM: Keeping teaching and learning strong. *Teaching Children Mathematics, 19* (1), 22-31.

Sakshaug, L., Olson, M., & Olson, J. (2002). *Children are mathematical problem solvers.* Reston, VA: National Council of Teachers of Mathematics.

Sakshaug, L., & Wohlhunter, K. (2010). Journey toward teaching mathematics through problem solving. *School Science and Mathematics, 110* (8), 397-409.

Schorr, R. (2000). Impact at the student level: A study of the effects of a teacher development intervention on students' mathematical thinking. *Journal of Mathematical Behavior, 19,* 209-231.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Research, 15*(2), 4-14.

Shulman, L. (1987). Knowledge and teaching. Foundations of the new reform. *Harvard Educational Review, 57*(1), 1-22.

Sowder, J. (2007). The mathematical education and development of teachers. In F.K. Lester, Jr. (Ed.), *Second handbook of research on mathematics teaching and learning: A*

project of the National Council of Teachers of Mathematics (pp.157-223). Charlotte, NC: Information Age Publishing.

Stanic, G., & Kilpatrick, J. (1988). Historical perspectives on problem solving in the mathematics curriculum. In Randall, C. (Ed.), *The teaching and assessing of mathematical problem solving* (pp.1-22). Reston, VA: National Council of Teachers of Mathematics.

Sztajn, P., Marrongelle, K., Smith, P., & Melton, B. (2012). Supporting implementation of the Common Core State Standards for Mathematics: Recommendation for professional development. Raleigh, NC: *Resource.*

Wei, R.C., Darling-Hammond, L., Andree, A., Richardson, N., & Orphanos, S. (2009). *Professional Learning in the Learning Profession: A Status Report on Teacher Development in the United States and Abroad*. Oxford, OH: National Staff Development Council.

Wood, T., Cobb, P., & Yackel, E. (1991). Change in teaching mathematics: A case study. *American Educational Research Journal, 28* (3), 587-616.

Weiss, I., & Pasley J. (2004). What Is high-quality instruction? *Educational Leadership, 61* (5), 24–28.

Woodward, J., Beckmann, S., Driscoll, M., Franke, M., Herzig, P., Jitendra, A., Koedinger, K. R., & Ogbuehi, P. (2012). *Improving mathematical problem solving in grades 4 through 8: A practice guide* (NCEE 2012-4055). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

Appendix

Interview Questions

1. What grade level do you teach?

2. How many years have you been teaching?

3. What do you think about the Common Core math standards and the Standards of Mathematical Practices?

4. How prepared do you personally feel to teach the Common Core State Math Standards and Standards of Mathematical practices?

5. How will the implementation of the Common Core Math Content Standards require you to make changes in your teaching practices?

    -How will the implementation of the standards of mathematical practices change your teaching practices?

6. What have you done to incorporate the SMP into your teaching practices?

    -Which of the SMP are you comfortable using?

    (1) Make sense of problems and persevere in solving them.

    (2) Reason abstractly and quantitatively.

    (3) Construct viable arguments and critique the reasoning of others.

    (4) Model with mathematics.

(5) Use appropriate tools strategically.

(6) Attend to precision (communication with others using clear definitions in discussion and in their own reasoning).

(7) Look for and make use of structure.

(8) Look for and express regularity in repeated reasoning

7. Tell me about any concerns you have about using the SMP in your teaching.

   -Tell me about concerns you have about your students learning the SMP.

8. How has (or has not) professional development opportunities supported you in the implementation of the Common Core State Standards for Mathematics Content (CCSSM) and/or the SMP?

9. We have looked at the Seven Shifts in classroom practices. What is your perception of these shifts?

   Shift from same instruction toward differentiated instruction.

   Shift from students working individually toward community of learners.

   Shift from mathematical authority coming from the teacher or textbook toward mathematical authority coming from sound student reasoning.

   Shift from teacher demonstrating "how to" toward teacher communicating "expectations" for learning.

   Shift from content taught in isolation toward content connected to prior knowledge.

   Shift from focus on correct answer toward focus on explanation and understanding.

   Shift from mathematics-made-easy for students toward engaging students in productive struggle.

- Which of these practices did you use before common core standards and which have you started using recently?

-Of these shifts which one(s) do you want to focus on in your teaching in the future?

-Is there one you find more challenging than the others?

10. What do you see as future professional development topics that would support you in the implementation process of CCSSM and the SMP?

    - What do you see as needed classroom support during this process?

11. Some teachers consider that by increasing student voice in the classroom and/or not having traditional textbooks to guide their instruction as risk in this education change, what do you consider as risks in this process?

12. Do you feel you have the opportunity to discuss your concerns and needs with staff on or off your school site?

13. Do you have any other comments regarding PD or the Common Core Standards & Mathematical Practices you would like to share with me?